#13

LIBRARY

MAY 2 1989

National Marine Fisheries Service
2570 Dole Street
Honolulu, Hawaii

NOAA Technical Report NMFS 73

February 1989

Marine Flora and Fauna of the Eastern United States Mollusca: Cephalopoda

Michael Vecchione, Clyde F.E. Roper, and Michael J. Sweeney

NOAA
Tech.
Rept.
NMFS
73

U.S. Department of Commerce

NOAA TECHNICAL REPORT NMFS

The major responsibilities of the National Marine Fisheries Service (NMFS) are to monitor and assess the abundance and geographic distribution of fishery resources, to understand and predict fluctuations in the quantity and distribution of these resources, and to establish levels for their optimum use. NMFS is also charged with the development and implementation of policies for managing national fishing grounds, development and enforcement of domestic fisheries regulations, surveillance of foreign fishing off United States coastal waters, and the development and enforcement of international fishery agreements and policies. NMFS also assists the fishing industry through marketing service and economic analysis programs, and mortgage insurance and vessel construction subsidies. It collects, analyzes, and publishes statistics on various phases of the industry.

The NOAA Technical Report NMFS series was established in 1983 to replace two subcategories of the Technical Reports series: "Special Scientific Report—Fisheries" and "Circular." The series contains the following types of reports: Scientific investigations that document long-term continuing programs of NMFS; intensive scientific reports on studies of restricted scope; papers on applied fishery problems; technical reports of general interest intended to aid conservation and management; reports that review in considerable detail and at a high technical level certain broad areas of research; and technical papers originating in economics studies and from management investigations. Since this is a formal series, all submitted papers receive peer review and those accepted receive professional editing before publication.

Copies of NOAA Technical Reports NMFS are available free in limited numbers to governmental agencies, both Federal and State. They are also available in exchange for other scientific and technical publications in the marine sciences. Individual copies may be obtained from: U.S. Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Although the contents have not been copyrighted and may be reprinted entirely, reference to source is appreciated.

34. Additions to a revision of the shark genus *Carcharhinus*: Synonymy of *Aprionodon* and *Hypoprion*, and description of a new species of *Carcharhinus* (Carcharhinidae), by J. A. F. Garrick. November 1985, 26 p.

35. Synoptic review of the literature on the Southern oyster drill *Thais haemastoma floridana*, by Philip A. Butler. November 1985, 9 p.

36. An egg production method for estimating spawning biomass of pelagic fish: Application to the northern anchovy, *Engraulis mordax*, by Reuben Lasker (editor). December 1985, 99 p.

37. A histopathologic evaluation of gross lesions excised from commercially important North Atlantic marine fishes, by Robert A. Murchelano, Linda Despres-Patanjo, and John Ziskowski. March 1986, 14 p.

38. Fishery atlas of the northwestern Hawaiian Islands, by Richard N. Uchida and James H. Uchiyama (editors). September 1986, 142 p.

39. Survey of fish protective facilities at water withdrawal sites on the Snake and Columbia Rivers, by George A. Swan, Tommy G. Withrow, and Donn L. Park. April 1986, 34 p.

40. Potential impact of ocean thermal energy conversion (OTEC) on fisheries, by Edward P. Myers, Donald E. Hoss, Walter M. Matsumoto, David S. Peters, Michael P. Seki, Richard N. Uchida, John D. Ditmars, and Robert A. Paddock. June 1986, 33 p.

41. A stationary visual census technique for quantitatively assessing community structure of coral reef fishes, by James A. Bohnsack and Scott P. Bannerot. July 1986, 15 p.

42. Effects of temperature on the biology of the northern shrimp, *Pandalus borealis*, in the Gulf of Maine, by Spencer Apollonio, David K. Stevenson, and Earl E. Dunton, Jr. September 1986, 22 p.

43. Environment and resources of seamounts in the North Pacific, by Richard N. Uchida, Sigeiti Hayasi, and George W. Boehlert (editors). September 1986, 105 p.

44. Synopsis of biological data on the porgies, *Calamus arctifrons* and *C. proridens* (Pisces: Sparidae), by George H. Darcy. September 1986, 19 p.

45. Meristic variation in *Sebastes* (Scorpaenidae), with an analysis of character association and bilateral pattern and their significance in species separation, by Lochai Chen. September 1986, 17 p.

46. Distribution and relative abundance of pelagic nonsalmonid nekton off Oregon and Washington 1979-84, by Richard D. Brodeur and William G. Pearcy. December 1986, 85 p.

47. Reproduction, maturation, and seed production of cultured species: Proceedings of the twelfth U.S.-Japan meeting on aquaculture, Baton Rouge, Louisiana, October 25-29, 1983, by Carl J. Sindermann (editor). February 1987, 73 p.

48. Widow rockfish: Proceedings of a workshop, Tiburon, California, December 11-12, 1980, by William H. Lenarz and Donald R. Gunderson (editors). January 1987, 57 p.

49. Reproduction, movements, and population dynamics of the southern kingfish, *Menticirrhus americanus*, in the northwestern Gulf of Mexico, by Stephen M. Harding and Mark E. Chittenden, Jr. March 1987, 21 p.

NMFS Honolulu Library
00000000004765

50. Preparation of acetate peels of valves from the ocean quahog, *Arctica islandica*, for age determinations, by John W. Ropes. March 1987, 5 p.

51. Status, biology, and ecology of fur seals. Proceedings of an international workshop, Cambridge, England, 23-27 April 1984, by John P. Croxall and Roger L. Gentry (editors). June 1987, 212 p.

52. Limited access alternatives for the Pacific groundfish fishery, by Daniel D. Huppert (editor). May 1987, 45 p.

53. Ecology of east Florida sea turtles: Proceedings of the Cape Canaveral, Florida, sea turtle workshop, Miami, Florida, February 26-27, 1985, by Wayne N. Witzell (convener and editor). May 1987, 80 p.

54. Proximate and fatty acid composition of 40 southeastern U.S. finfish species, by Janet A. Gooch, Malcolm B. Hale, Thomas Brown, Jr., James C. Bonnet, Cheryl G. Brand, and Lloyd W. Reiger. June 1987, 23 p.

55. Proximate composition, energy, fatty acid, sodium, and cholesterol content of finfish, shellfish, and their products, by Judith Krzynowek and Jenny Murphy. July 1987, 53 p.

56. Some aspects of the ecology of the leatherback turtle *Dermochelys coriacea* at Laguna Jolova, Costa Rica, by Harold F. Hirth and Larry H. Ogren. July 1987, 14 p.

57. Food habits and dietary variability of pelagic nekton off Oregon and Washington, 1979-1984, by Richard D. Brodeur, Harriet V. Lorz, and William G. Pearcy. July 1987, 32 p.

58. Stock assessment of the Gulf of Menhaden, *Brevoortia patronus*, fishery, by Douglas S. Vaughan. September 1987, 18 p.

59. Atlantic Menhaden, *Brevoortia tyrannus*, purse seine fishery, 1972-84, with a brief discussion of age and size composition of the landings, by Joseph W. Smith, William R. Nicholson, Douglas S. Vaughan, Donnie L. Dudley, and Ethel A. Hall. September 1987, 23 p.

60. Gulf Menhaden, *Brevoortia patronus*, purse seine fishery, 1974-85, with a brief discussion of age and size composition of the landings, by Joseph W. Smith, Eldon J. Levi, Douglas S. Vaughan, and Ethen A. Hall. December 1987, 8 p.

61. Manual for starch gel electrophoresis: A method for the detection of genetic variation, by Paul B. Aebersold, Gary A. Winans, David J. Teel, George B. Milner, and Fred M. Utter. December 1987, 19 p.

62. Fishery publication index, 1980-85; Technical memoradum index, 1972-85, by Cynthia S. Martin, Shelley E. Arenas, Jacki A. Guffey, and Joni M. Packard. December 1987, 149 p.

63. Stock assessment of the Atlantic Menhaden, *Brevoortia tyrannus*, fishery, by Douglas S. Vaughan and Joseph W. Smith. January 1988, 18 p.

64. Illustrated key to penaeoid shrimps of commerce in the Americas, by Isabel Perez Farfante. April 1988, 32 p.

65. History of whaling in and near North Carolina, by Randall R. Reeves and Edward Mitchell. March 1988, 28 p.

66. Atlas and zoogeography of common fishes in the Bering Sea and Northeastern Pacific, by M. James Allen and Gary B. Smith. April 1988, 151 p.

NOAA Technical Report NMFS 73

Marine Flora and Fauna of the Eastern United States Mollusca: Cephalopoda

Michael Vecchione
Clyde F.E. Roper
Michael J. Sweeney

February 1989

U.S. DEPARTMENT OF COMMERCE
Robert Mosbacher, Secretary
National Oceanic and Atmospheric Administration
William E. Evans, Under Secretary for Oceans and Atmosphere
National Marine Fisheries Service
James Brennan, Assistant Administrator for Fisheries

Library
NOAA, National Marine Fisheries Service
SWFC Honolulu Laboratory F/SWC2
2570 Dole Street
Honolulu, HI 96822-2396

Foreword

This NOAA Technical Report NMFS is part of the subseries "Marine Flora and Fauna of the Eastern United States" (formerly "Marine Flora and Fauna of the Northeastern United States"), which consists of original, illustrated, modern manuals on the identification, classification, and general biology of the estuarine and coastal marine plants and animals of the eastern United States. The manuals are published at irregular intervals on as many taxa of the region as there are specialists available to collaborate in their preparation. These manuals are intended for use by students, biologists, biological oceanographers, informed laymen, and others wishing to identify coastal organisms for this region. They can often serve as guides to additional information about species or groups.

The manuals are an outgrowth of the widely used "Keys to Marine Invertebrates of the Woods Hole Region," edited by R.I. Smith, and produced in 1964 under the auspices of the Systematics Ecology Program, Marine Biological Laboratory, Woods Hole, Massachusetts. Geographic coverage of the "Marine Flora and Fauna of the Eastern United States" is planned to include organisms from the headwaters of estuaries seaward to approximately the 200-m depth on the continental shelf from Maine to Florida, but can vary somewhat with each major taxon and the interests of collaborators. Whenever possible, representative specimens dealt with in the manuals are deposited in the reference collections of major museums.

The "Marine Flora and Fauna of the Eastern United States" is being prepared in collaboration with systematic specialists in the United States and abroad. Each manual is based primarily on recent and ongoing revisionary systematic research and a fresh examination of the plants and animals. Each manual, treating a separate major taxon, includes an introduction, illustrated glossary, uniform originally illustrated keys, annotated checklist (with information, when available, on distribution, habitat, life history, and related biology), references to the major literature of the group, and a systematic index.

Manuals are available from the National Technical Information Service, United States Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, either as a paper copy or microfiche, for a charge. Manuals are not copyrighted, and so can be photocopied from the NOAA Technical Report NMFS Circulars and Reports available in most major libraries and listed on p. 23 of this manual.

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

Contents

Introduction **1**

Glossary **2**

Key to neritic cephalopods of the northeastern United States **7**

Annotated systematic list **16**

Some recently published comprehensive works on cephalopods **20**

Citations **20**

Systematic index **21**

Acknowledgments **21**

Coordinating Editor's comments **22**

List of published manuals in the Marine Flora and Fauna series **23**

Digitized by the Internet Archive
in 2025

https://archive.org/details/noaa-technical-report-nmfs-ssrf_1989-02_73

Marine Flora and Fauna of the Eastern United States Mollusca: Cephalopoda

MICHAEL VECCHIONE
National Marine Fisheries Service, NOAA
Systematics Laboratory
National Museum of Natural History
Washington, DC 20560

CLYDE F.E. ROPER
MICHAEL J. SWEENEY
Department of Invertebrate Zoology—Mollusks
National Museum of Natural History
Smithsonian Institution
Washington, DC 20560

Abstract

The cephalopods found in neritic waters of the northeastern United States include myopsid and oegopsid squids, sepiolid squids, and octopods. A key with diagnostic illustrations is provided to aid in identification of the eleven species common in the neritic waters between Cape Hatteras and Nova Scotia; included also is information on two oceanic species that occur over the continental shelf in this area and that can be confused with similar-looking neritic species. Other sections comprise a glossary of taxonomic characters used for identification of these species, an annotated systematic checklist, and checklists of the 89 other oceanic species and 18 Carolinian and subtropical neritic species that might occur occasionally off the northeastern United States.

'A pile of fresh squid lay on the deck, and the larger cod thinks very well of a little shiny piece of squid tentacle at the tip of a clam-baited hook. Next day they caught many fish, and met the "Carrie Pittman," to whom they shouted their luck, and she wanted to trade—seven cod for one fair-sized squid; but Disko would not agree at the price, and the "Carrie" dropped sullenly to leeward and anchored half a mile away, in hope of striking on to some for herself.'

Rudyard Kipling
Captains Courageous

Introduction

Cephalopods are very important, both to the marine ecosystem and to humans. They can be abundant predators that are large, active, and voracious; conversely, they are important as prey for many marine mammals, birds, and fishes, including economically important species. Substantial squid fisheries have existed in North America almost exclusively to provide bait for other fisheries. Cephalopods also are important as food for people in many parts of the world. Furthermore, they are important in biomedical research; much of what is known about neurophysiology results from experiments with the giant axon of squids, a contributing factor in the founding of the Marine Biological Laboratory at Woods Hole, Massachussetts.

The classification of recent taxa of the molluscan Class Cephalopoda (see Voss 1977) includes the squids (Order Teuthoidea), the octopods (Order Octopoda), and the cuttlefishes and sepiolid or bobtailed squids (Order Sepioidea), as well as the bizarre vampire squid in the monotypic Order Vampyromorpha and the chambered nautilus in the separate subclass Nautiloidea. Teuthoid squids are further distinguished based on whether their eyes are covered by a transparent cornea (Suborder Myopsida) or are exposed (Suborder Oegopsida). The fauna of the northeastern United States lacks nautiloids and true cuttlefishes but does include myopsid and oegopsid squids, octopods, and sepiolid squids; the vampyromorph *Vampyroteuthis infernalis* occurs in this geographic area but is limited to the deep waters of the bathypelagic realm.

Although the cephalopods of the northeastern United States have not been reviewed since the works of Verrill (1880, 1881), considerable collecting has been done in this region. Many species of cephalopods have been collected off the northeastern United States and can be divided into two ecological groups:

1) Species of the neritic zone with life histories restricted to obligate relationships with the comparatively shallow waters of the continental shelf (some of these species can also be found on the continental slope); and

2) oceanic species found primarily in open oceanic waters away from the shelf and slope (some of these species can also be found in shelf and slope waters).

We discuss here the cephalopod species commonly found in neritic waters of the northeastern United States. This work is based largely upon extensive collections of cephalopods deposited throughout the last century in the National Museum of Natural History (NMNH). These collections are a result of efforts by fishermen, individual researchers, institutional research programs, and government agencies. The old U.S. Commission of Fish and Fisheries and its descendents, the Bureau of Commercial Fisheries and, finally, the National Marine Fisheries Service (NMFS) have conducted comprehensive trawling along the northeastern United States for groundfish surveys, and cephalopods from these surveys have been deposited at the National Museum. The area of coverage for this paper extends from Cape Hatteras to Nova Scotia.

The scope of this presentation does not include the many oceanic species of squids and octopods normally found in deep waters beyond the continental slope, although any of these species could move inshore to the slope or shelf under conditions such as impingement of a Gulf-Stream eddy onto the shelf. Examination of the NMNH collections demonstrates, however, that a few oceanic species are sufficiently common in neritic waters and similar enough to neritic species to cause confusion. Therefore, two of these oceanic species are included in the key, but this is not intended to be a comprehensive guide to all oceanic species that can be transported into neritic waters by Gulf-Stream eddies or other mechanisms.

Cephalopod morphology changes substantially during growth. Some species hatch as planktonic "paralarvae" (Young and Harman 1988), and the greatest morphological changes occur during the transition between the paralarval and juvenile phases of the life cycle. Paralarval morphology and ecology have not been determined for many species (Okutani 1987, Vecchione 1987). Thus, the key is designed for identification of adults and advanced juveniles but does not apply to paralarvae and early juveniles.

Glossary

This glossary is derived from a more complete illustrated listing of taxonomic characters presented by Roper et al. (1984). Interested readers also should consult Roper and Voss (1983).

Anal flaps Pair of fleshy palps that arise at the sides of the anus in teuthoid and sepioid squids (Fig. 1).

Anterior Toward the head end or toward the arm tips.

Carpal knobs Small rounded protuberances on the carpus of the tentacular club to which carpal suckers from the opposite club adhere during the locking-together of the clubs.

Carpus Proximal zone of the tentacular club which often has small suckers and/or knobs (Fig. 2).

Cartilaginous tubercles Semi-rigid to rigid structures in the skin of certain squids; can be overlapping and scale-like, or simple to multifaceted knobs or papillae.

Cirri Fleshy erectile protuberances of the skin, usually elongate and finger-like (Fig. 3).

Corneal membrane Thin, transparent skin that covers the eyes of myopsid and sepioid squids and octopods (Fig. 2).

Dactylus Distal, terminal zone of the tentacular club, often characterized by comparatively small suckers (Fig. 2).

Dorsal Uppermost surface, opposite the ventral surface where the funnel is located.

Fin angle Angle between the longitudinal axis of the mantle and the posterior border of one fin (Fig. 4).

Fins Pair of muscular flaps that arise along the dorsolateral surface of the mantle, usually in its posterior half (Fig. 2).

Foveola Transverse membranous fold of skin that forms a pocket in the funnel groove of some oegopsid squids (Fig. 5).

Funnel Ventral tube through which water is expelled from the mantle cavity (Fig. 2).

Funnel organ Glandular structures on the internal dorsal and ventral surfaces of the funnel (Fig. 6).

Gladius Feather- or rod-shaped chitinous supporting structure in the dorsal mantle of squids (Fig. 7).

Hectocotylus One or more arms in males of some cephalopod species, modified for transferring spermatophores to the female; modifications can involve the suckers, sucker stalks, protective membranes, and/or trabeculae (Fig. 8).

Hooks Chitinous claw-like structures derived from the suckers on the arms and/or tentacles of some oegopsid squids (Fig. 2).

Light organ Simple or complex structure that produces bioluminescence (also termed photophore).

Ligula Spatulate, or spoon-shaped, terminal structure of the hectocotylus of octopods (Fig. 9).

Mantle Tubular or sac-like muscular body of cephalopods (Fig. 2).

Mantle length Standard measure of size, is abbreviated ML (Fig. 10).

Posterior Toward the closed end of the mantle, away from the head and arms.

Rachis Thickened central axis that usually extends the entire length of the gladius. The free rachis is the portion that does not support vanes (Fig. 7).

Side pockets Structures formed by small membranous folds of integument lateral to the foveola in the funnel groove of some oegopsids (Fig. 5).

Suckers Muscular suction-cups on the arms and tentacles and occasionally on the the membrane around the mouth. Suckers of squids are mounted on thin muscular stalks and include chitinous rings with teeth (Fig. 11).

Tentacles Elongate pair of appendages located between the ventral and ventrolateral arms (Arms III and IV) of squids and cuttlefishes (Fig. 2); with a proximal stalk usually devoid of suckers or hooks, and with a distal club armed with suckers and occasionally hooks.

Tentacular club Terminal, usually expanded, portion of tentacle, armed with suckers or, in some groups, with suckers and/or hooks (Fig. 11).

Trabeculae Muscular rods that support the protective membranes on the arms and tentacular clubs; occasionally the membranes are reduced and trabeculae are elongated so they project beyond the edge of the membrane as papillae (Fig. 8).

Vane Thin lateral expansion of the gladius that arises from the rachis (Fig. 7).

Ventral Lower surface of the animal; side on which the funnel is located.

Water pores Small orifices in the integument at the bases of some arms on some pelagic octopods (Fig. 12).

Web Membrane that extends between the arms of many octopods and sepiolid squids (Fig. 13).

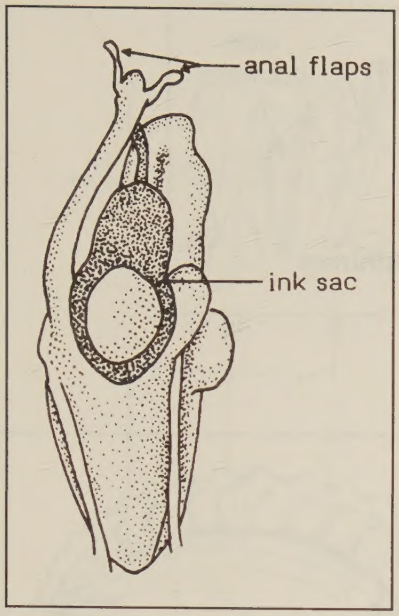

Figure 1
Ventral aspect of a squid visceral mass (schematic).

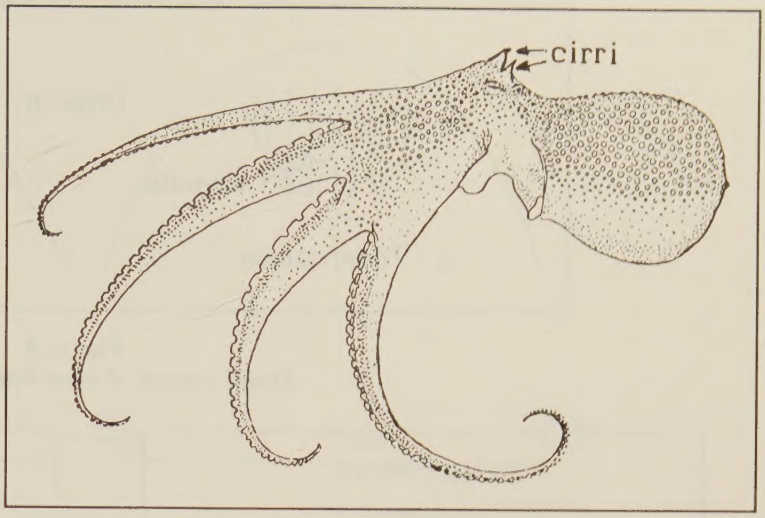

Figure 3
Lateral aspect of an octopod.

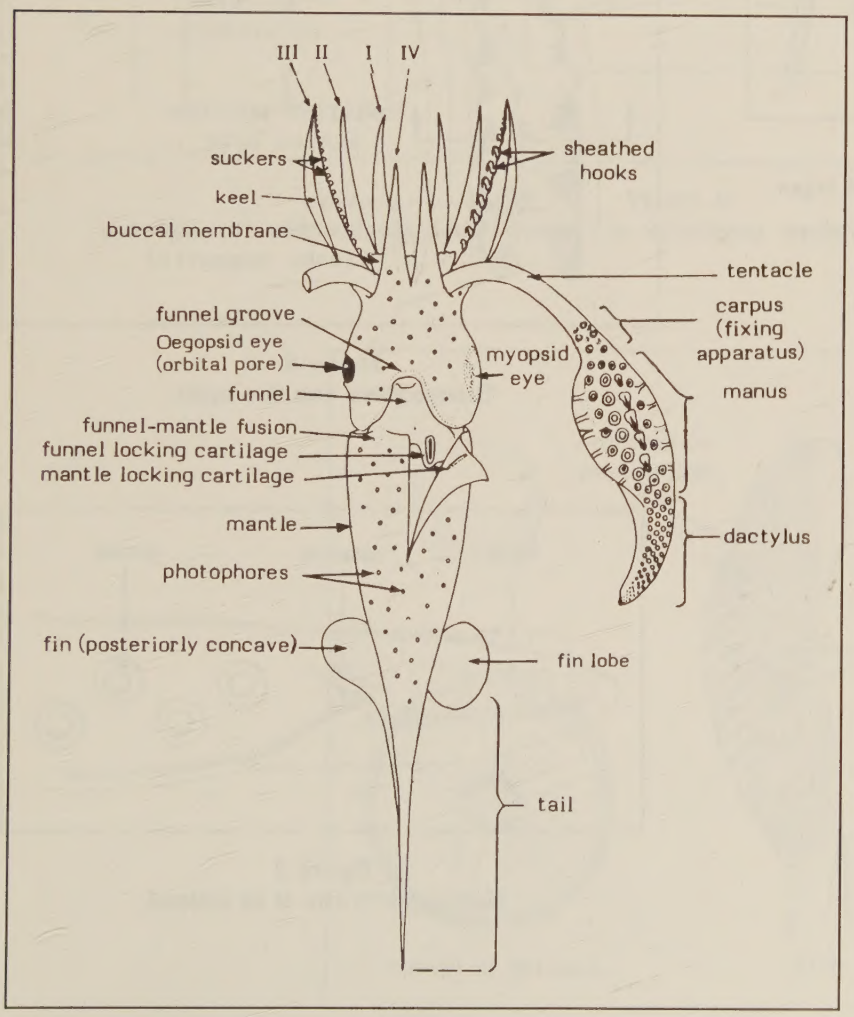

Figure 2
Composite diagram illustrating basic squid features, ventral aspect.

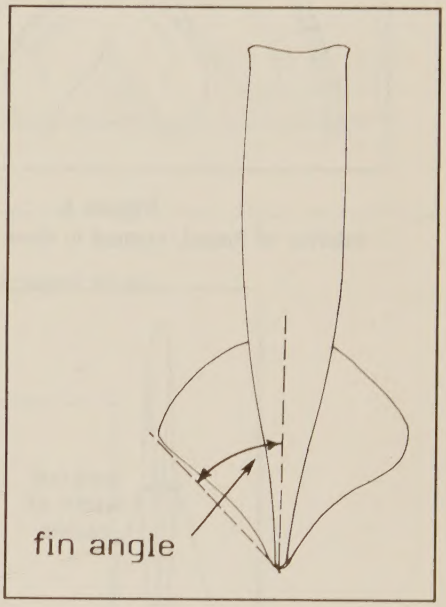

Figure 4
Measurement of fin angle.

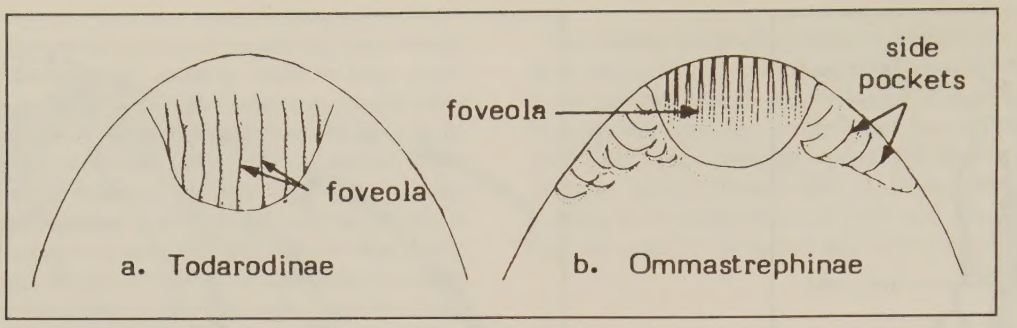

Figure 5
Funnel grooves of some Ommastrephidae.

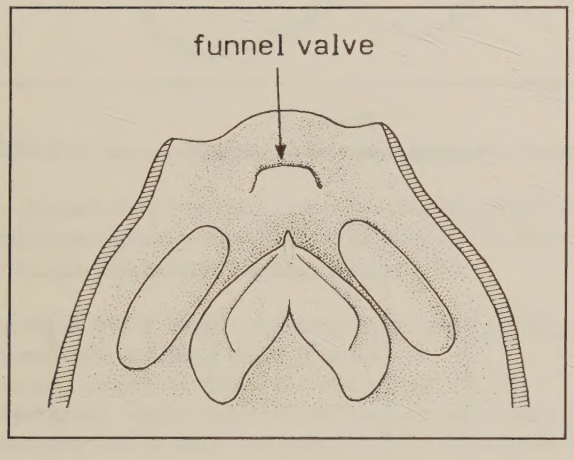

Figure 6
Interior of funnel, opened to show funnel organ.

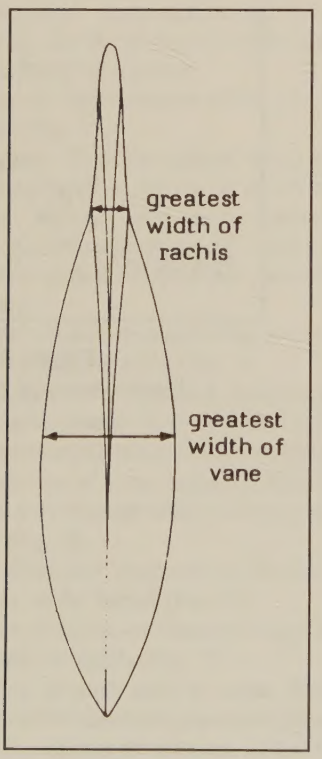

Figure 7
Gladius, showing measurement of rachis and vane.

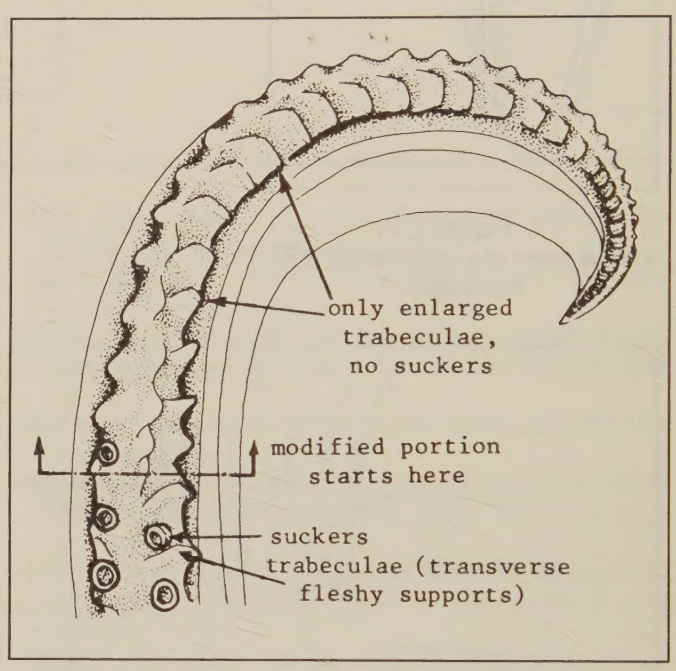

Figure 8
Hectocotylized arm of a squid.

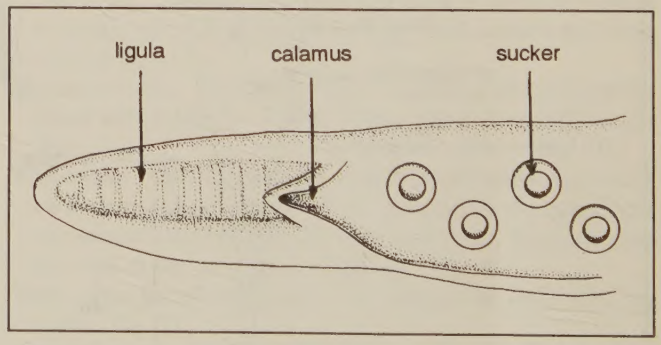

Figure 9
Hectocotylized arm of an octopod.

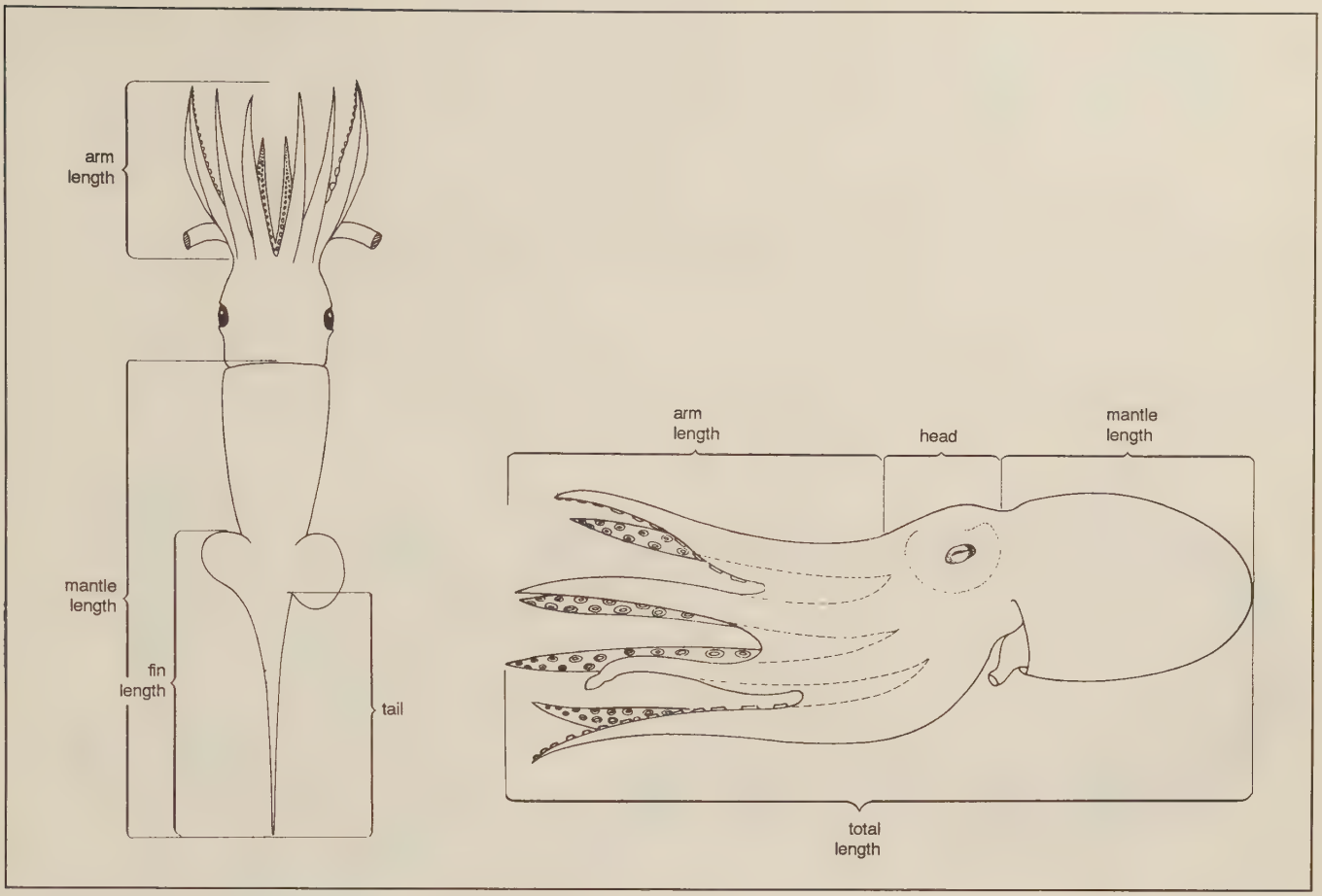

Figure 10
Some standard measurements on cephalopods. Squid (left); octopod (right).

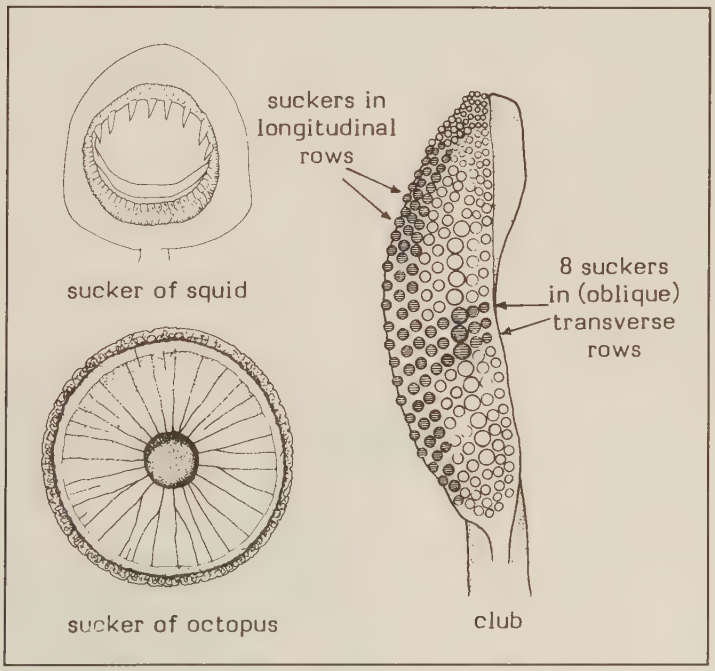

Figure 11
Suckers and configuration of suckers (schematic) on tentacular club.

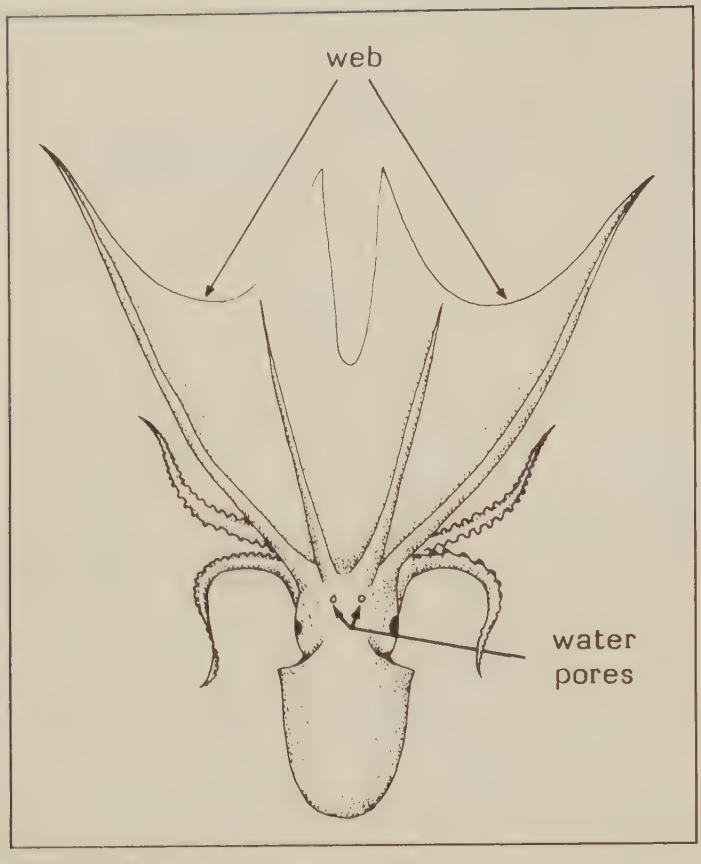

Figure 12
The pelagic octopod *Tremoctopus*.

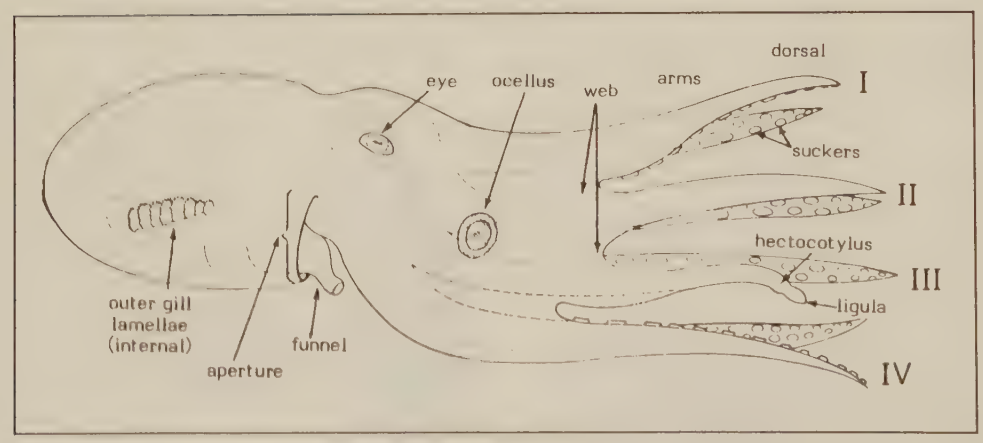

Figure 13
Schematic lateral aspect of octopod features.

Key to neritic cephalopods of the northeastern United States

1 Suckers with narrow stalks and with chitinous rings that might be modified into hooks; usually ten circumoral appendages comprised of eight arms and two tentacles (tentacles, however, can be lost during development)—squids and sepioids 4

1 Suckers without stalks and without chitinous rings or hooks; eight circumoral appendages (arms only)—octopods 2

2(1) Any of the following characters present: fins; body gelatinous; water pores located on ventral surface of head at base of arms; broad membranous flaps on dorsal arms; left third arm coiled in sac below eye .....**oceanic octopods**

2(1) None of the characters listed above 3

3(2) Ink sac absent in adults; arms short; suckers small; a large cirrus located dorsal to each eye; right arm III of males hectocotylized with huge, broad, spade-shaped ligula with prominent transverse ridges .....***Bathypolypus arcticus*** **(Fig. 14)**

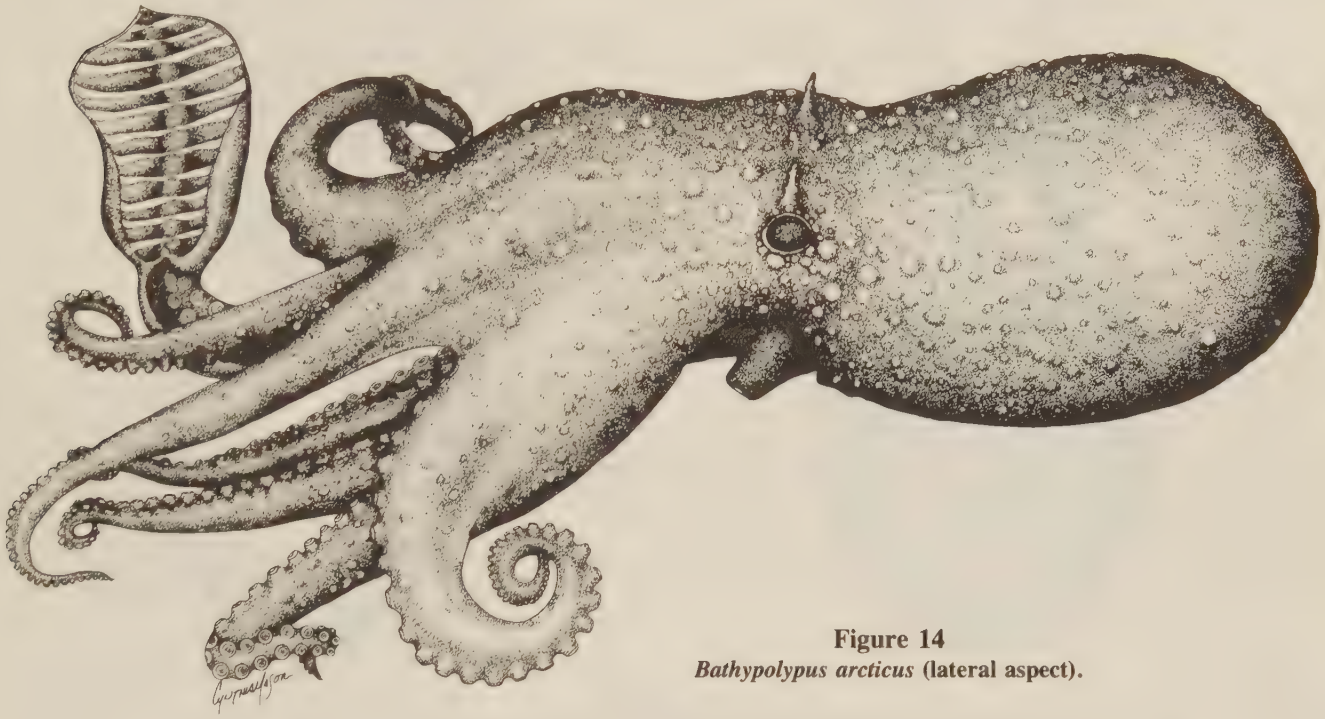

Figure 14
Bathypolypus arcticus **(lateral aspect).**

3(2) Ink sac present; arms moderately long; suckers large; cirri above eyes small or absent; ligula of hectocotylized right arm III of males very small .....***Octopus vulgaris*** **(Fig. 15)**

Figure 15
Octopus vulgaris **(lateral aspect).**

4(1) Any of the following characters present: suckers modified into hooks; numerous conspicuous light organs on surface of mantle, head, arms, or tentacles; tissues gelatinous; mantle surface with cartilaginous tubercles ..... **oceanic squids**

4(1) None of the characters listed above **5**

5(4) Fins extend to posterior tip of mantle, joined or nearly joined posteriorly **9**

5(4) Fins do not extend to posterior tip of mantle, broadly separate posteriorly **6**

6(5) Mantle fused with head dorsally; all arms except ventral pair united by broad web; ventral mantle broadly flattened into dark shield-like structure ..... ***Stoloteuthis leucoptera*** **(Fig. 16)**

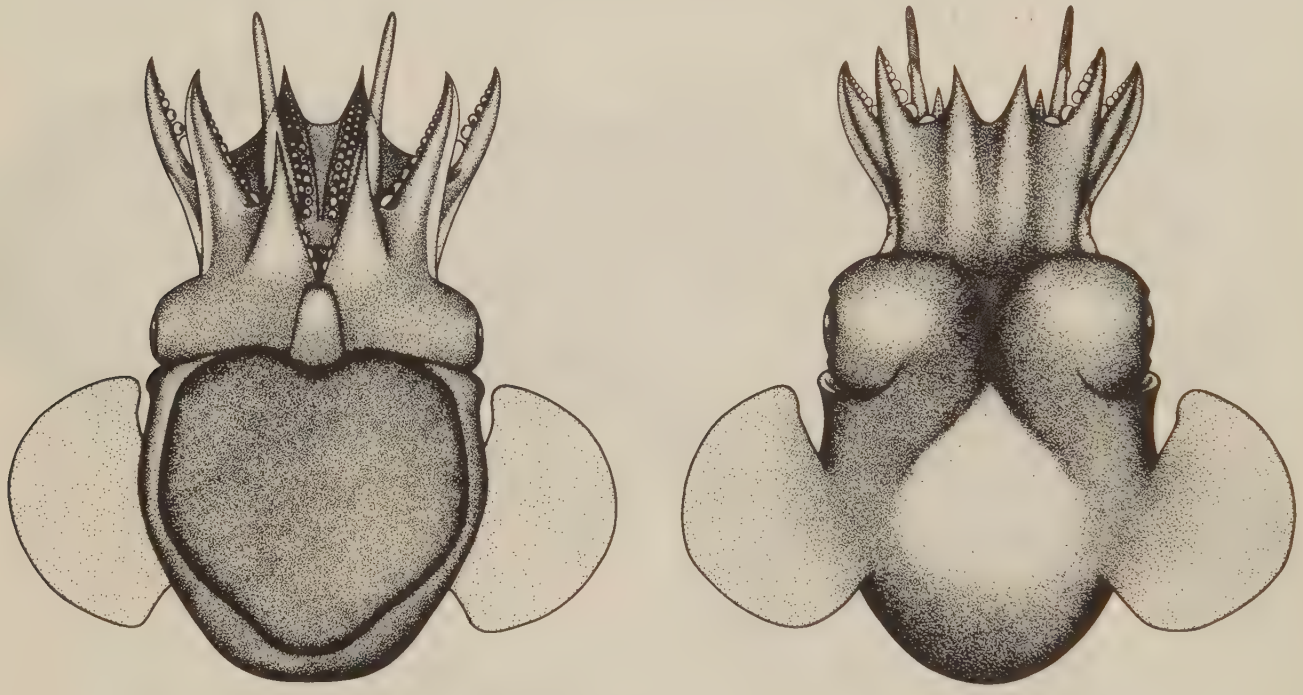

Figure 16
***Stoloteuthis leucoptera*. Ventral aspect (left); dorsal aspect (right).**

6(5) Mantle free from head dorsally; only arms III and IV united by a web; mantle rounded ventrally **7**

7(6) Light organs present on ink sac ..... *Semirossia tenera* **(Fig. 17)**

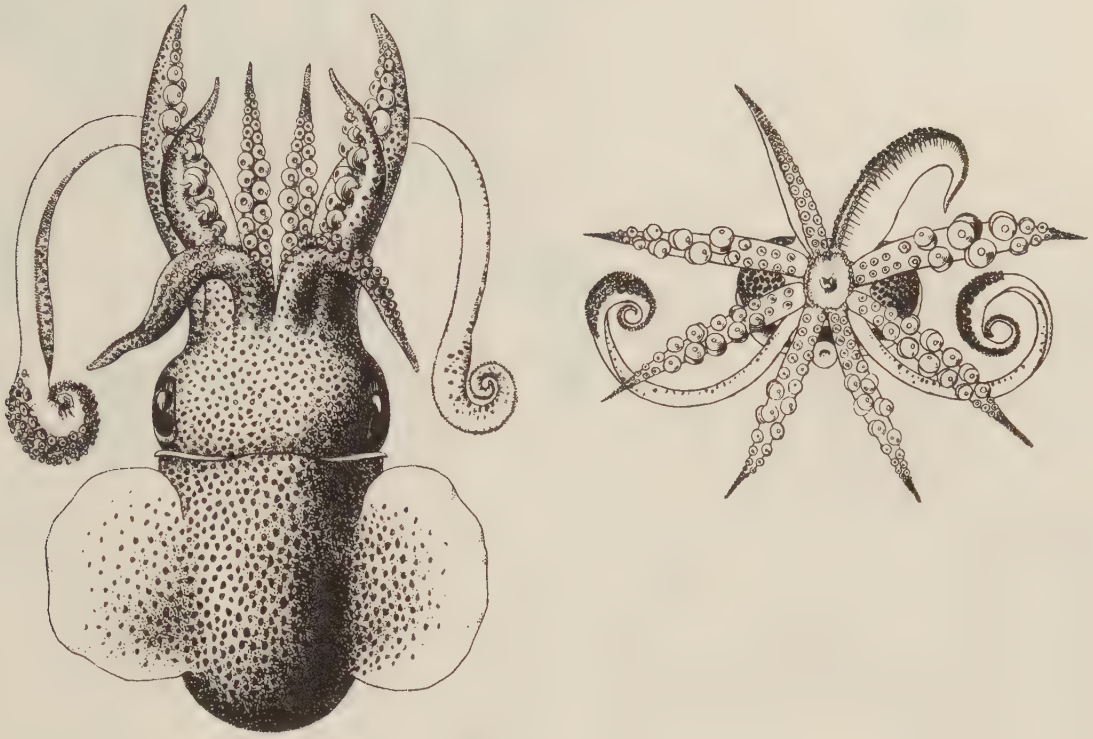

Figure 17
***Semirossia tenera*. Dorsal aspect (left); oral aspect of male (right).**

7(6) No light organs on ink sac **8**

8(7) Dorsal pad of funnel organ short, without posterior extensions; anal flaps large, with expanded blades **(Fig.18 left)** .. .. *Rossia palpebrosa* **(Fig. 19)**

Figure 18
Anal palps, funnel organs, and funnel valves. *Rossia palpebrosa* (left); *Rossia megaptera* (right).

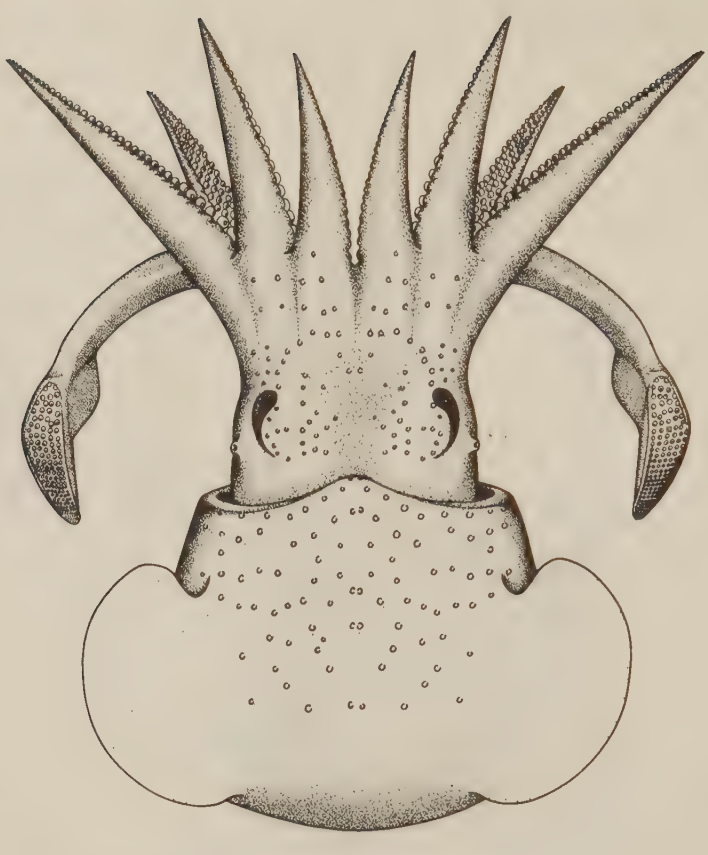

Figure 19
Rossia palpebrosa **(dorsal aspect).**

8(7) Dorsal pad of funnel organ long, with angles and posterior extensions on both sides; anal flaps small, without expanded blades **(Fig. 18 right)** ..... ***Rossia megaptera*** **(Fig. 20)**

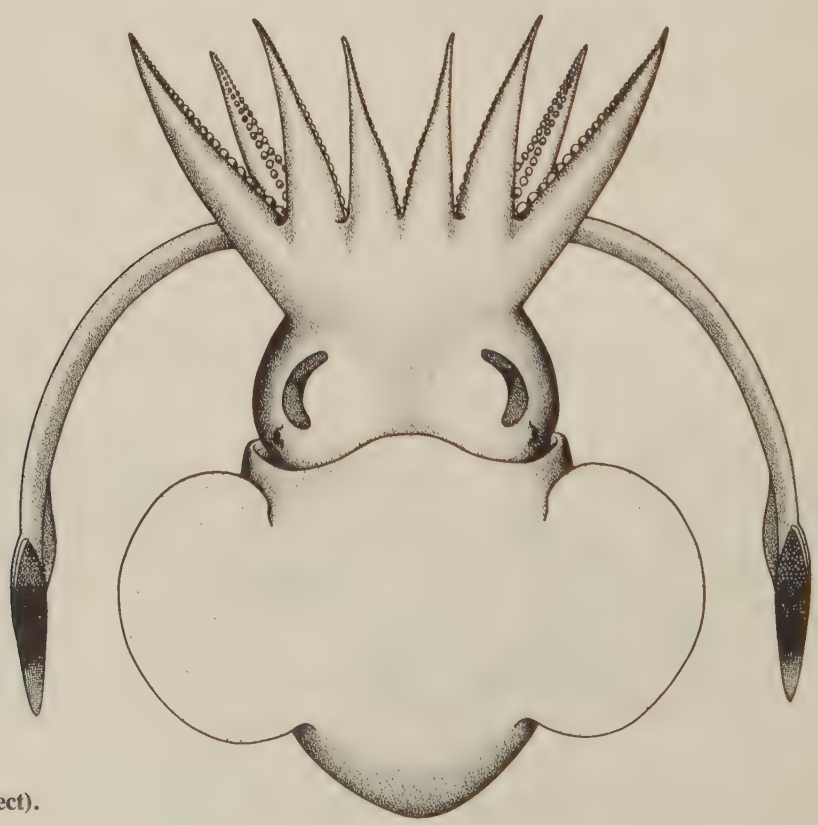

Figure 20
Rossia megaptera **(dorsal aspect).**

9(5) Eye covered by a cornea **10**

9(5) Eye without a cornea **12**

10(9) Fins in adults wider than long ..... ***Lolliguncula brevis*** **(Fig. 21)**

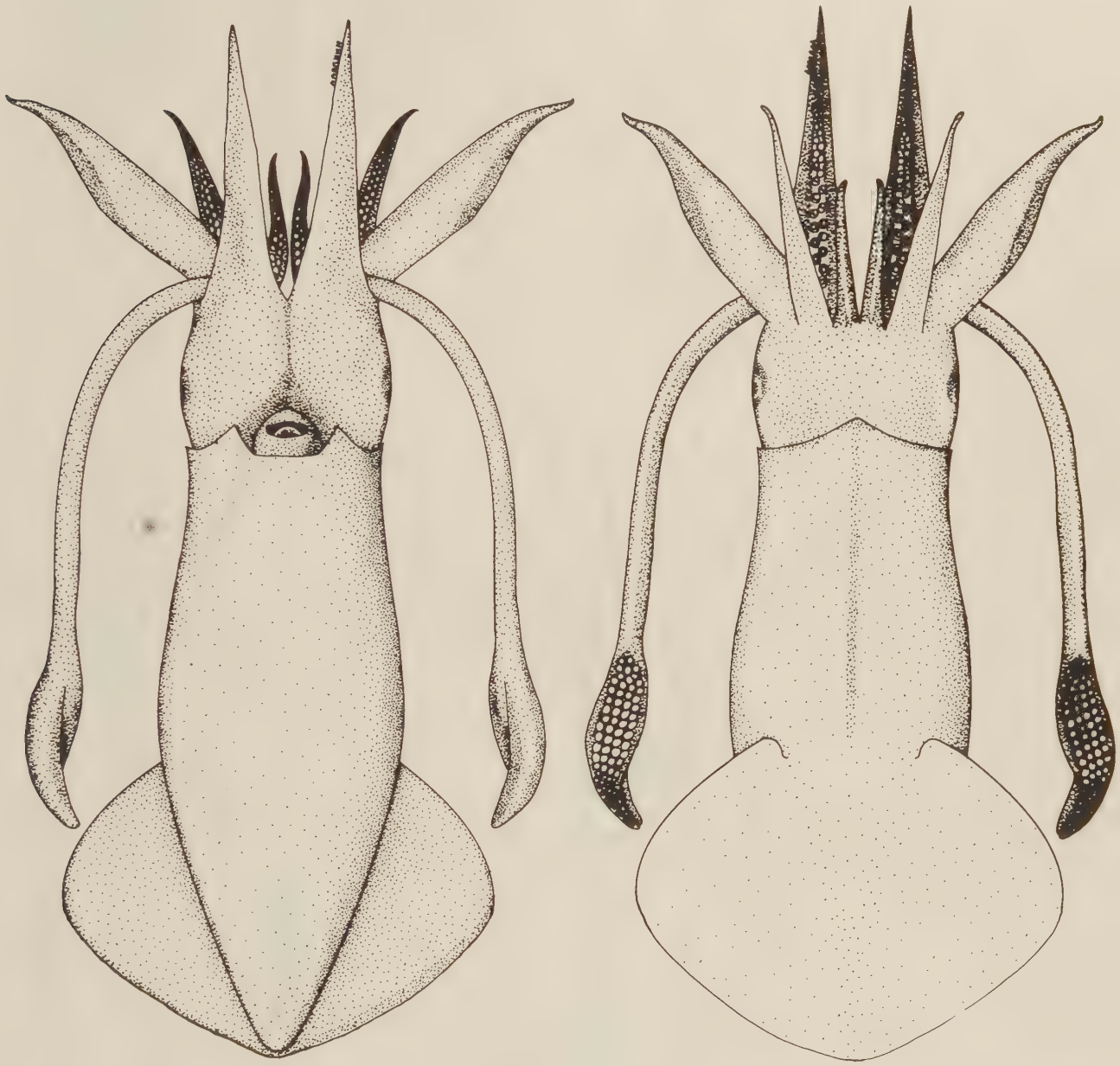

Figure 21
***Lolliguncula brevis*. Ventral aspect (left); dorsal aspect (right).**

10(9) Fins in adults as long as or longer than wide **11**

11(10) Ratio of greatest width of gladius vane to greatest width of free rachis is 2.4-3.7 **(Fig. 22)**; lateral margin of gladius vane usually thin although sometimes slightly darkened in preserved specimens; modified suckers in hectocotylized left ventral arm of males do not extend to arm tip ..... ***Loligo pealei*** **(Fig. 23)**

Figure 22
Gladii. *Loligo pealei* (left); *Loligo plei* (right).

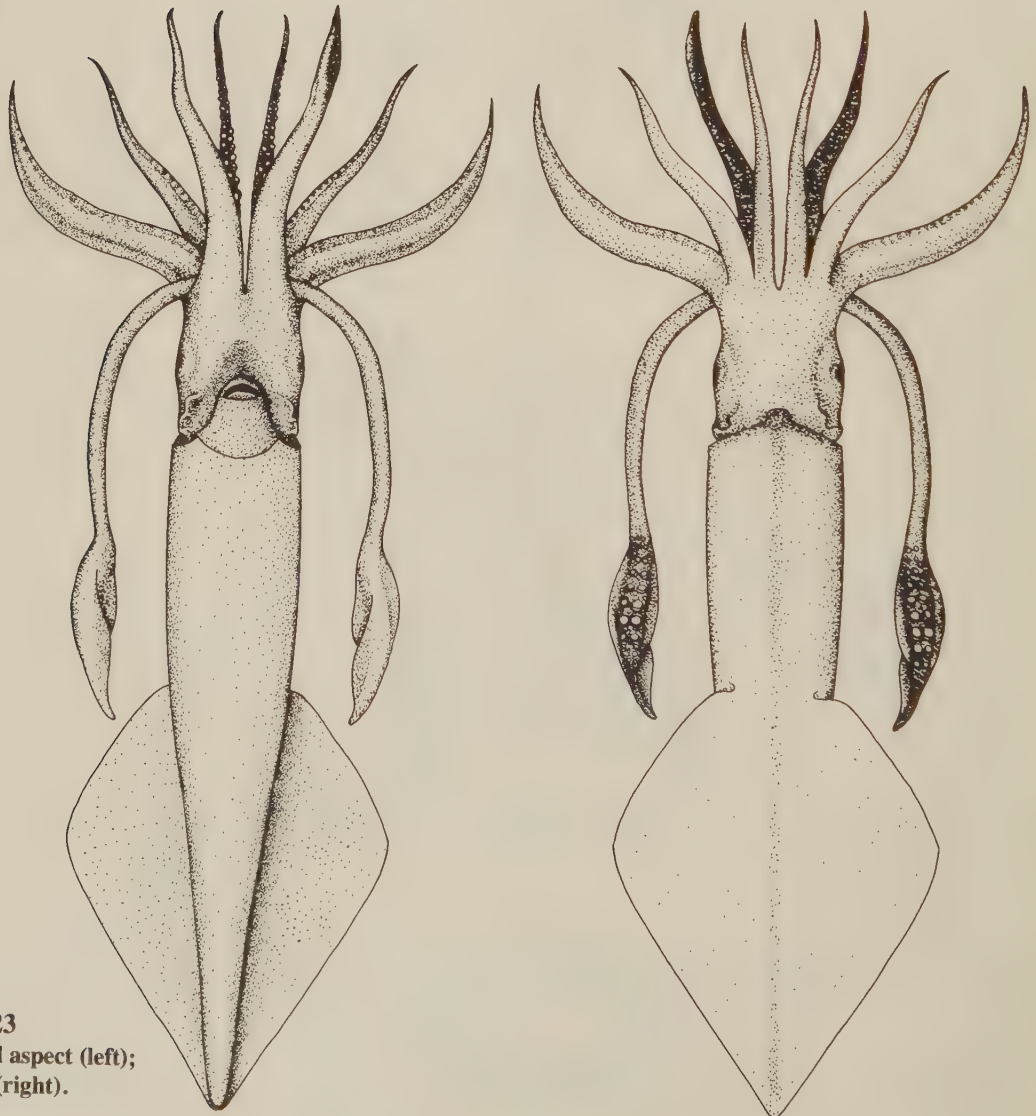

Figure 23
***Loligo pealei*. Ventral aspect (left); dorsal aspect (right).**

11(10) Ratio of greatest width of gladius vane to greatest width of gladius free rachis is 1.5-2.4; lateral margin of gladius vane usually thickened; modified suckers in hectocotylized left ventral arm of males extend to arm tip . . . . . ***Loligo plei*** **(Fig. 24)**

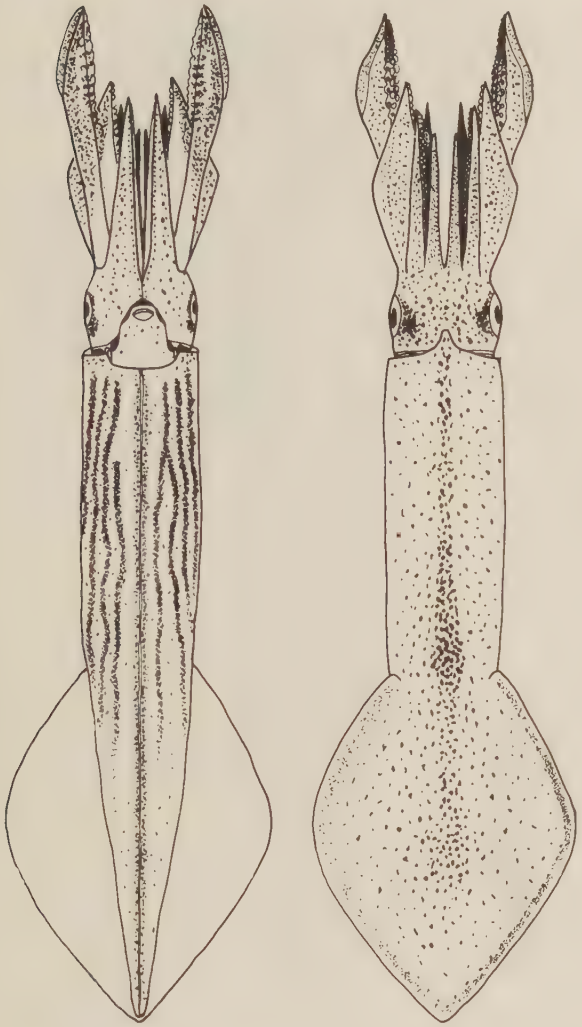

Figure 24
***Loligo plei*. Ventral aspect (left); dorsal aspect (right).**

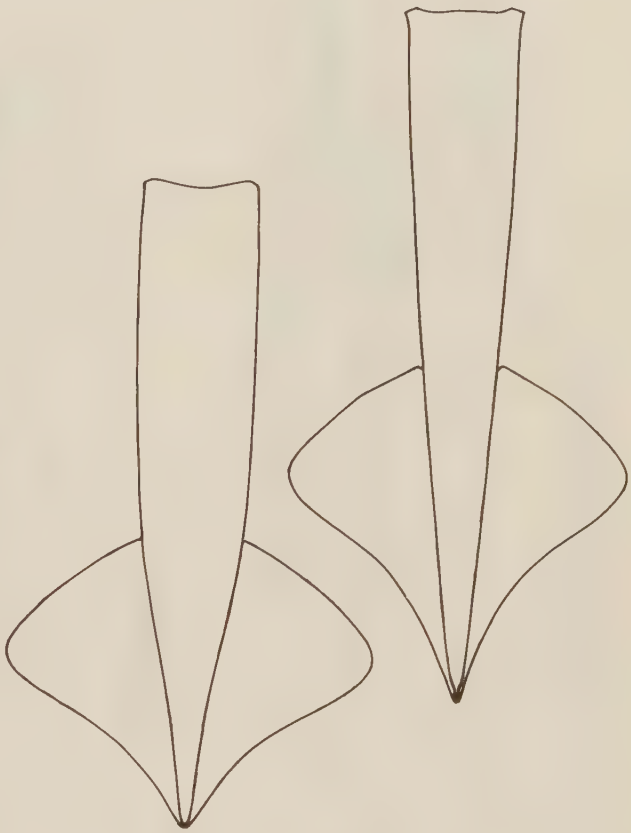

Figure 25
Comparison of ventral aspects of mantle and fin outline.
***Illex illecebrosus* (left); *I. oxygonius* (right).**

12(9) Dactylus of tentacular club with eight longitudinal rows of small suckers; funnel groove smooth, without foveola or side pockets **13**

12(9) Dactylus of tentacular club with four longitudinal rows of small suckers; funnel groove with foveola and side pockets **14**

13(12) Fin angle 40-50° **(Fig. 25 left)**; modified portion of hectocotylized ventral arm in mature males occupies about 15-25% of hectocotylized-arm length; head not noticably wider than mantle opening; suckers on lateral arms of males not enlarged ..... ***Illex illecebrosus*** **(Fig. 26)**

13(12) Fin angle 25-40° **(Fig. 25 right)**; modified portion of hectocotylized ventral arm in mature males occupies about 30-35% of hectocotylized-arm length; head wider than mantle opening; suckers on lateral arms of males enlarged ..... ***Illex oxygonius*** **(Fig. 27)**

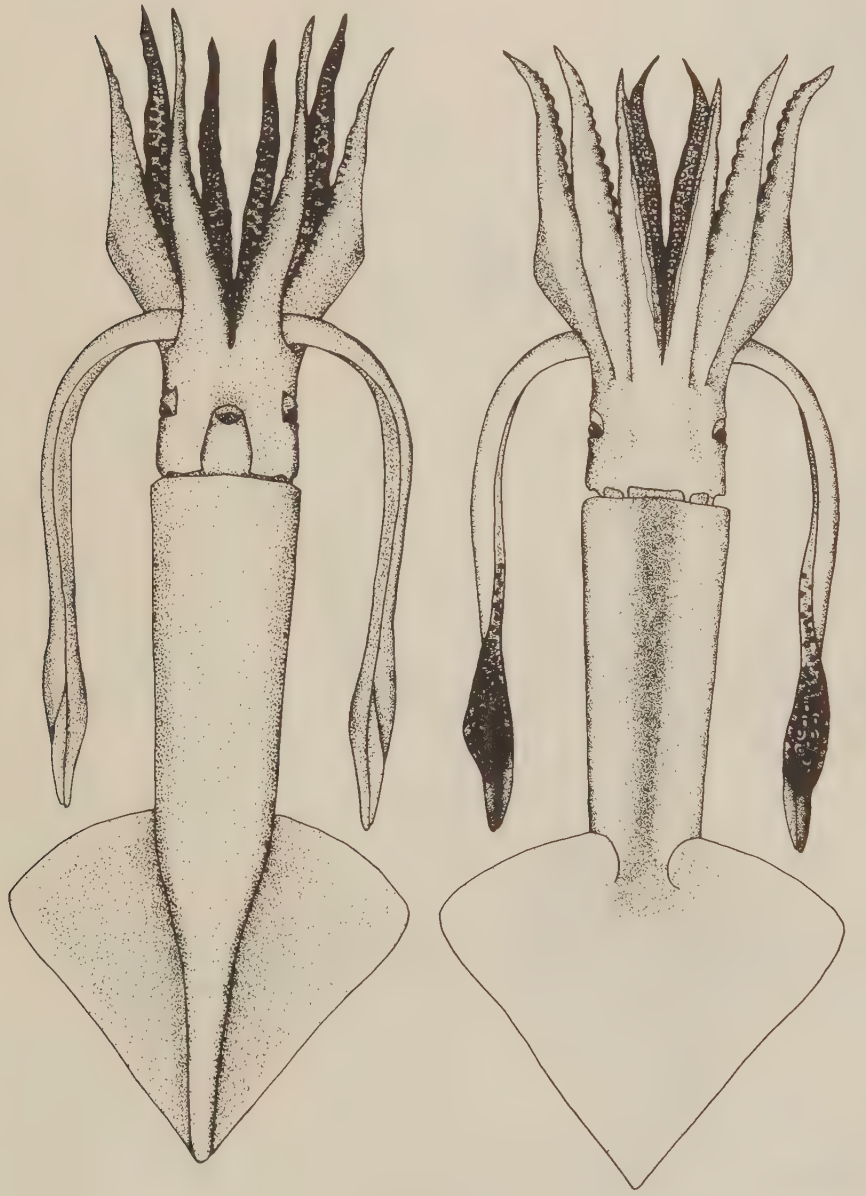

Figure 26
***Illex illecebrosus*. Ventral aspect (left); dorsal aspect (right).**

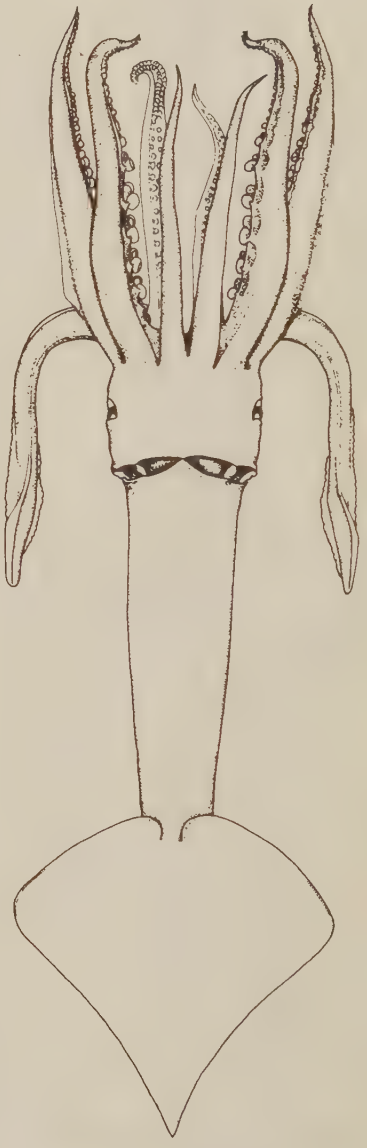

Figure 27
***Illex oxygonius* (dorsal aspect).**

14(12) Large, diffuse, compound light organ beneath integument on anterodorsal surface of mantle; not more than two suckers occur proximal to knobs on carpus of tentacular club; no reflective stripe on midline of ventral mantle ..... ***Ommastrephes pteropus*** **(Fig. 28)**

14(12) No large dorsal light organ; longitudinal reflective stripe present along ventral midline of mantle surface; four to seven suckers occur proximal to first knob on carpal part of tentacular club ..... ***Ommastrephes bartrami*** **(Fig. 29)**

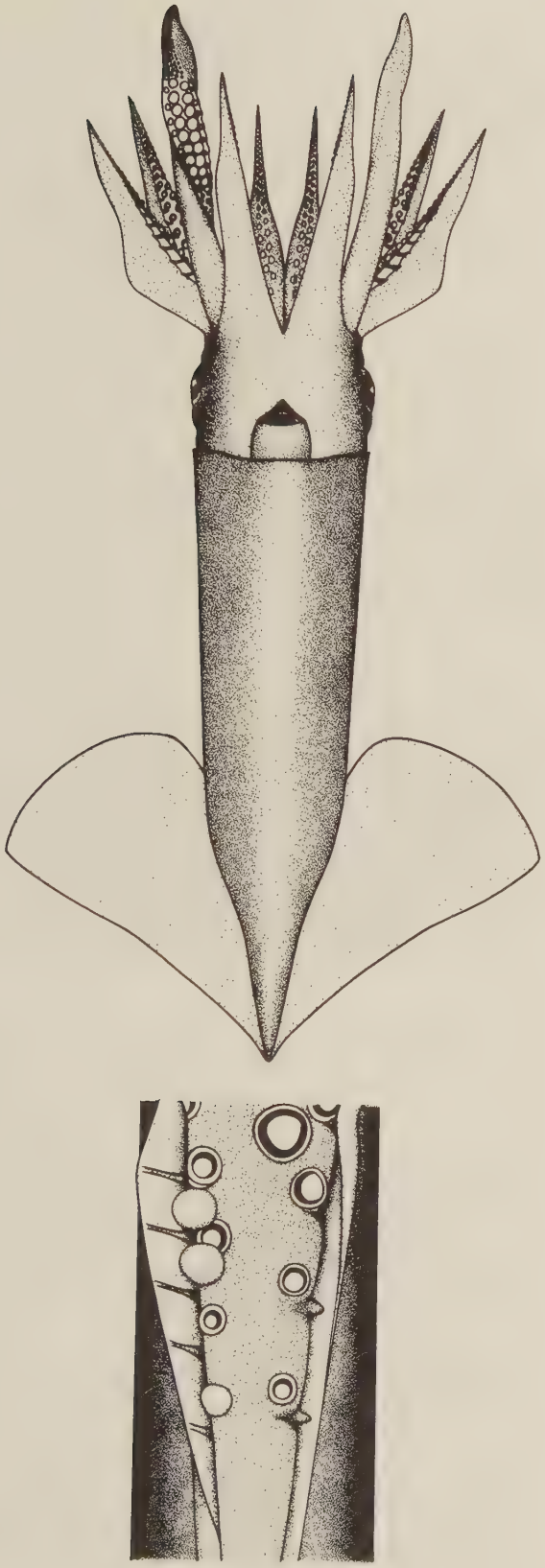

Figure 28
Ommastrephes pteropus. Ventral aspect (top); carpal region of tentacular club (bottom).

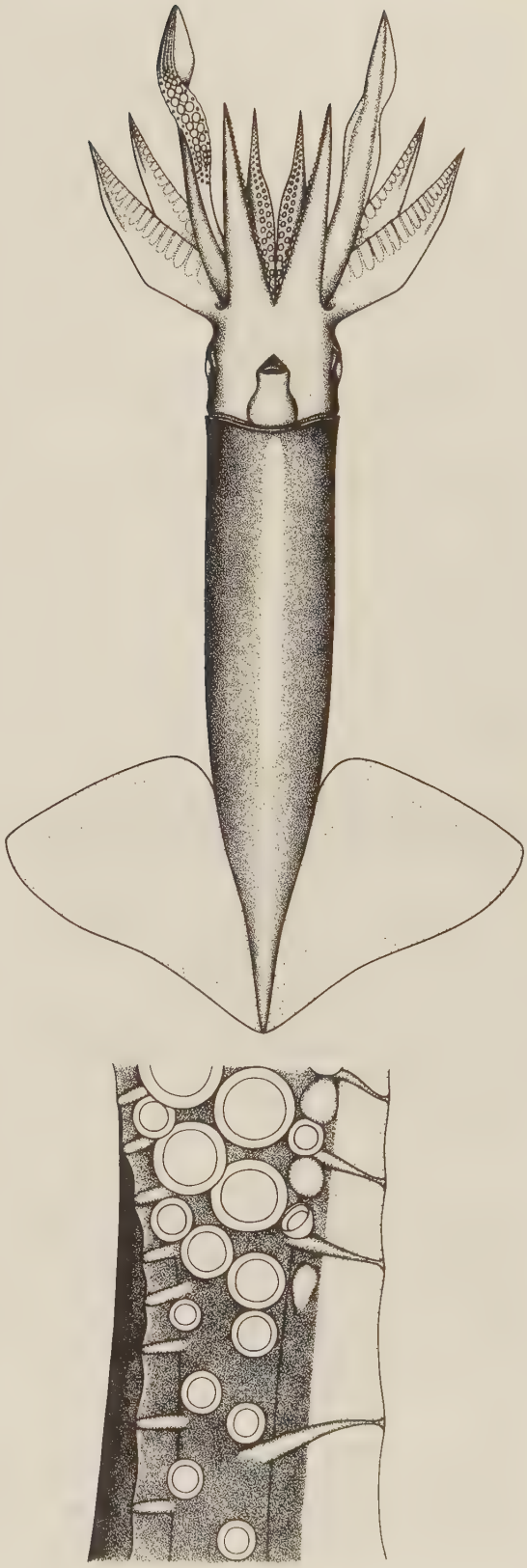

Figure 29
Ommastrephes bartrami. Ventral aspect (top); carpal region of tentacular club (bottom).

The generic status of at least some species in each family of cephalopods discussed here is currently unsettled. Species-level systematics also might change in the Octopodidae, Sepiolidae, and Ommastrephidae from this area when thorough revisions have been completed. A review of the published literature and an examination of the collections of the National Museum of Natural History reveal that, in addition to the eleven species of neritic cephalopods we list from the northeastern United States, 91 oceanic species might occasionally be transported into these waters, and 18 other neritic species that generally are confined to Carolinian or subtropical waters might stray north of Cape Hatteras under unusual oceanographic circumstances.

1 Neritic species

Order Sepioidea

FAMILY SEPIOLIDAE

Bobtailed squids are small benthic animals more closely related to the cuttlefishes than to the true teuthoid squids. Species-level systematics are confused, and the entire family, with many species around the world, is in need of revision.

***Rossia megaptera* Verrill 1881, Fig. 20.** This little-known species occurs from New York to Greenland on the outer shelf and slope at depths of 125-1500 m, with a maximum size of about 40 mm ML.

***Rossia palpebrosa* Owen 1834, Fig. 19.** An Arctic-Boreal species known from Greenland and the Canadian Arctic to South Carolina in the western Atlantic and from Spitzbergen to the North Sea in the eastern Atlantic. In the NMFS Groundfish-Survey collections, it is scattered along the outer shelf at depths of 88-175 m. Grows to about 45 mm ML. *Rossia glauposis* Loven 1846 and *R. sublaevis* Verrill 1878 probably are junior synomyms (Nesis 1987).

***Semirossia tenera* (Verrill 1880), Fig. 17.** Common on sand and mud bottoms on the central shelf at depths of 85-135 m, *S. tenera* is known to occur from the Gulf of Maine to the Gulf of Mexico and Caribbean Sea. Also reported from Surinam and French Guiana (Okutani 1983). Attains a size of about 50 mm ML. This is the only species of *Semirossia* from the northeastern United States, but its relationships with several other nominal species in the southern part of its range are confusing.

***Stoloteuthis leucoptera* (Verrill 1878), Fig. 16.** This beautiful little cephalopod has seldom been reported since Verrill's description. Apparently, however, it is not rare, as several hundred specimens are included in the NMFS Groundfish-Survey collections. *Stoloteuthis leucoptera* seems to be relatively common on the outer shelf and slope of the Gulf of Maine at depths of 175-340 m, and is found as far south as the Straits of Florida. This species, which reaches 25 mm ML, can be distinguished easily from all other neritic sepiolids in the Atlantic by the ventral shield-like structure of the mantle.

Order Teuthoidea

FAMILY LOLIGINIDAE

The systematics of the Loliginidae currently are in turmoil. In a little more than a decade, at least four different generic-level classifications have been proposed for species that include those we refer to as *Loligo* (Cohen 1976; Natsukari 1984; G.L. Voss, Univ. Miami, pers. commun., 1984; Brakoniecki 1986). We retain this generic designation for both species as a matter of continuity until such problems are resolved.

Although *L. pealei* and *L. plei* are distinct species, they are very similar and often are difficult to separate. Cohen (1976) examined 50 taxonomic characters and concluded that *L. pealei* and *L. plei* overlap in all but two: the structure of the hectocotylus and the ratio of vane width to rachis width in the gladius. Five other characters were found that, although overlapping, differed significantly between the two species. Furthermore, the two species are most similar in geographical areas where they are sympatric.

***Loligo pealei* Lesueur 1821, Fig. 23.** A very abundant species in the waters off the northeastern United States, *L. pealei* is the target of important commercial fisheries. Also the primary source of giant axons for neurological research in this region.

Loligo pealei occurs over the continental shelf and upper slope from the surface to about 400 m depth. It is found throughout the western North Atlantic from Newfoundland to Brazil, but apparently not around the islands of the Caribbean Sea (Cohen 1976). Vecchione (1981) described the early life history of *L. pealei*, and Summers (1983) reviewed the many published studies of its biology and ecology. Attains a maximum size of 500 mm ML.

***Loligo plei* Blainville 1823, Fig. 24.** *Loligo plei* tends to be limited to warmer waters than *L. pealei*. Where the two species are sympatric, *L. pealei* is usually found in deeper water than *L. plei*, although considerable overlap occurs. The maximum depth reported for *L. plei* is 370 m. *Loligo plei* is rare north of Cape Hatteras but has been collected as far north as the New York Bight. Its range extends south at least to southern Brazil and includes the islands of Bermuda, the Bahamas, and the Caribbean Sea, where it is sympatric with two other species currently assigned to the genus *Loligo*. Reported to reach a size of at least 350 mm ML.

***Lolliguncula brevis* (Blainville 1823), Fig. 21.** A species that is noteworthy for its euryhalinity, *L. brevis* is common in coastal waters from Delaware Bay south to Brazil and is the only species of cephalopod frequently caught in estuaries. Throughout its range, it is found in waters less than 20 m deep. Haefner (1964) compared the morphometrics of *L. brevis*, which attains a relatively small size of 120 mm ML, with the larger-growing *L. pealei* from the Middle Atlantic Bight; Vecchione (1982) described the development of *L. brevis*.

Order Teuthoidea (continued)

FAMILY OMMASTREPHIDAE

The family Ommastrephidae is currently under revision by several authors; numerous questions need to be resolved on a worldwide basis at both the generic and the species levels. Most members of the family are oceanic, but a few genera, including *Illex*, are strongly associated with the continental shelf and slope (although occasionally they are found far offshore). This is the only family included in the key whose species spawn pelagically.

***Illex illecebrosus* (Lesueur 1821), Fig. 26.** This very abundant species is important in commercial fisheries. Its depth range extends from the surface to probably about 1000 m. A seasonal migration transports *I. illecebrosus* from the Gulf Stream right up to the shoreline. Geographical range includes the western Atlantic from the Straits of Florida to Greenland and Iceland and extends eastward to the British Isles; however, the eastern Atlantic populations may represent a separate species, *I. coindetii*, or subspecies. *Illex illecebrosus* grows to 350 mm ML. O'Dor (1983) reviewed the life history of *I. illecebrosus*, and its larval development and ecology have been discussed by Roper and Lu (1979), Vecchione (1979), and Vecchione and Roper (1986).

***Illex oxygonius* Roper, Lu, and Mangold 1969, Fig. 27.** Except for mature adult males, *I. oxygonius* is very difficult to distinguish from *I. illecebrosus*, especially where the two species are sympatric. *Illex oxygonius*, however, has been found only as far north as Delaware and appears to be rare north of Cape Hatteras. It has been reported only as far south as Key West, Florida, although this could simply be an artifact of the difficulty in distinguishing *I. oxygonius* from *I. illecebrosus* and *I. coindetii*. *Illex oxygonius* has been reported from waters with bottom depths of 50-550 m and attains a size of 230 mm ML. Its distribution was summarized by Roper et al. (1984).

Order Octopoda

FAMILY OCTOPODIDAE

Octopod morphology is quite variable, making the taxonomy difficult. Morphometric indices, such as relative lengths of the arms, are often used in describing species but can be very misleading in any particular specimen because of the octopod's ability to extend or contract arms independently. Furthermore, artifacts of preservation can exacerbate this problem. Similarly, skin texture and color patterns can be of use in distinguishing among species, but, because these characters are related to different behavioral patterns and also can change dramatically during fixation and preservation, they also can be misleading. The generic-level systematics of the family are currently under revision.

We recommend that a series of specimens be obtained, including (if possible) mature adults of both sexes. For example, adult males of *Octopus vulgaris* and *Bathypolypus arcticus* are easily distinguished based on the hectocotylus. Once the adult males of these species have been compared, it will be easier to identify the less easily distinguished juveniles without having to dissect them to determine if the internal ink sac is present. Differences in ovarian egg size are consistent and useful for identification of adult females. The eggs of *O. vulgaris* are 3 mm or less in length whereas those of *B. arcticus* are about 13 mm long.

***Octopus vulgaris* Cuvier 1797, Fig. 15.** Although this species occurs primarily south of Cape Hatteras, it is distributed as far north as Connecticut. The NMFS Groundfish-Survey collections from the Middle Atlantic Bight include several large specimens. As currently defined, this species has been reported from shallow (intertidal to 200-m depth) temperate and tropical waters of both the eastern and western North and South Atlantic Oceans, the Mediterranean Sea, Red Sea, Indian Ocean, and western Pacific Ocean. Possibly, though, this broad range might actually represent a complex of several similar, though currently unrecognized, species (Roper 1985). *Octopus vulgaris* has been reported to reach a size of 400 mm ML. The life cycle was reviewed by Mangold (1983).

***Bathypolypus arcticus* (Prosch 1849), Fig. 14.** The most abundant neritic octopod in the waters of the northeastern United States. It is a cold-water species that also is found in the deep water of the continental slope as far south as the Straits of Florida. A species with considerable morphological variation, it has been reported from eastern Canada, Greenland, Iceland, the North Sea, and Spitzbergen. It is usually caught in trawls on mud bottoms at depths of 14 to 1000 m, and attains a maximum size of about 100 mm ML. O'Dor and Macalaster (1983) reviewed the life history of *B. arcticus*.

2 Oceanic species

Both of these species are common in epipelagic and mesopelagic waters of the Gulf Stream. They are transported onto the continental shelf of the northeastern United States by Gulf-Stream eddies.

Order Teuthoidea

FAMILY OMMASTREPHIDAE

***Ommastrephes bartrami* (Lesueur 1821), Fig. 29.** Found in mid-latitude waters of the North and South Atlantic, Pacific, and Indian Oceans. It is absent from equatorial waters as well as from waters with temperatures of less than 10°C. In oceanic waters, *O. bartrami* occurs at the surface at night to about 1500 m depth.

***Ommastrephes pteropus* (Steenstrup 1855), Fig. 28.** A Pan-Atlantic species of tropical and warm-temperate waters, *O. pteropus* is found where surface waters are warmer than 22°C. It is known to migrate vertically between the surface and deep waters and has been reported at depths down to 1500 m. Nesis (1987) has proposed that this species be assigned to the genus *Sthenoteuthis*.

3 Other oceanic species

Species that might be found in the waters off northeastern United States and that have been recorded in oceanic waters north of 26°N and west of 60°W.

Order Sepioidea

FAMILY SPIRULIDAE

Spirula spirula (Linnaeus 1758)

FAMILY SEPIOLIDAE

Heteroteuthis dispar (Ruppell 1844)
Nectoteuthis pourtalesi Verrill 1883

Order Teuthoidea

FAMILY LYCOTEUTHIDAE

Lycoteuthis diadema (Chun 1900)
Selenoteuthis scintillans Voss 1958
Lampadioteuthis megaleia Berry 1916

FAMILY ENOPLOTEUTHIDAE

Abralia veranyi (Ruppell 1844)
Abralia redfieldi Voss 1955
Abralia grimpei Voss 1958
Abraliopsis hoylei (Pfeffer 1884)
Abraliopsis pfefferi Joubin 1896
Pyroteuthis margaritifera (Ruppell 1844)
Pterygioteuthis giardi Fischer 1895
Pterygioteuthis gemmata Chun 1908
Enoploteuthis anapsis Roper 1964
Enoploteuthis leptura (Leach 1817)
Ancistrocheirus lesueuri (d'Orbigny 1839)
Thelidioteuthis alessandrini (Verany 1851)
(probably = *A. lesueuri*)

FAMILY OCTOPOTEUTHIDAE

Octopoteuthis megaptera (Verrill 1885)
Octopoteuthis danae Joubin 1931
Taningia danae Joubin 1931

FAMILY ONYCHOTEUTHIDAE

Onychoteuthis banksii (Leach 1817)
Onykia carribaea Lesueur 1821
Ancistroteuthis lichtensteini (d'Orbigny 1839)

FAMILY CYCLOTEUTHIDAE

Cycloteuthis sirventi Joubin 1919
Discoteuthis discus Young and Roper 1969
Discoteuthis laciniosa Young and Roper 1969

FAMILY GONATIDAE

Gonatus fabricii (Lichtenstein 1818)
Gonatus steenstrupi Kristensen 1981

FAMILY LEPIDOTEUTHIDAE

Lepidoteuthis grimaldi Joubin 1895
Pholidoteuthis adami Voss 1956
Tetronychoteuthis dussumieri (d'Orbigny 1839)
Tetronychoteuthis massyae Pfeffer 1912

FAMILY HISTIOTEUTHIDAE

Histioteuthis bonnelli (Ferussac 1835)
Histioteuthis celetaria (Voss 1960)
Histioteuthis corona (Voss and Voss 1962)
Histioteuthis dofleini (Pfeffer 1912)
Histioteuthis elongata (Voss and Voss 1962)
Histioteuthis meleagroteuthis (Chun 1910)
Histioteuthis reversa (Verrill 1880)

FAMILY NEOTEUTHIDAE

Neoteuthis thielei Naef 1921

FAMILY BATHYTEUTHIDAE

Bathyteuthis abyssicola Hoyle 1885

FAMILY CTENOPTERYGIDAE

Ctenopteryx sicula (Verany 1851)

FAMILY BRACHIOTEUTHIDAE

Brachioteuthis beanii Verrill 1881
Brachioteuthis riisei (Steenstrup 1882)

FAMILY ARCHITEUTHIDAE

Architeuthis princeps Verrill 1875
(as well as other poorly defined species of *Architeuthis*)

FAMILY OMMASTREPHIDAE

Illex coindetii (Verany 1837)
Todarodes sagittatus (Lamarck 1799)
Ommastrephes caroli Furtado 1887 (may = *O. bartrami*)
Ornithoteuthis antillarum Adam 1957
Hyaloteuthis pelagica (Bosc 1802)

Order Teuthoidea (continued)

FAMILY THYSANOTEUTHIDAE

Thysanoteuthis rhombus Troschel 1857

FAMILY CHIROTEUTHIDAE

Chiroteuthis veranyi (Ferussac 1835)

FAMILY MASTIGOTEUTHIDAE

Mastigoteuthis grimaldii (Joubin 1895)
Mastigoteuthis hjorti Chun 1913
Mastigoteuthis magna Joubin 1913

FAMILY GRIMALDITEUTHIDAE

Grimalditeuthis bomplandii (Veranyi 1837)

FAMILY JOUBINITEUTHIDAE

Joubiniteuthis portieri (Joubin 1916)

FAMILY CRANCHIIDAE

Cranchia scabra Leach 1817
Liocranchia reinhardti (Steenstrup 1856)
Leachia cyclura Lesueur 1821
Leachia atlantica (Degner 1925)
Egea inermis Joubin 1933
Helicocranchia pfefferi Massy 1907
Galiteuthis armata Joubin 1898
Bathothauma lyromma Chun 1906
Sandalops melancholicus Chun 1906
Taonius pavo (Lesueur 1821)
Megalocranchia abyssicola (Goodrich 1896)
Megalocranchia oceanica (Voss 1960)
Megalocranchia speculator Chun 1906
Teuthowenia megalops (Prosch 1849)

Order Vampyromorpha

FAMILY VAMPYROTEUTHIDAE

Vampyroteuthis infernalis Chun 1903

Order Octopoda

FAMILY CIRROTEUTHIDAE

Cirroteuthis muelleri Eschricht 1838
Cirrothauma murrayi Chun 1911

FAMILY STAUROTEUTHIDAE

Stauroteuthis syrtensis Verrill 1879
Grimpoteuthis grimaldii (Joubin 1903)
Grimpoteuthis megaptera (Verrill 1885)
Grimpoteuthis umbellata (Fischer 1883)

FAMILY OPISTHOTEUTHIDAE

Opisthoteuthis agassizii Verrill 1883

FAMILY BOLITAENIDAE

Eledonella pygmaea Verrill 1884
Japetella diaphana Hoyle 1885

FAMILY VITRELEDONELLIDAE

Vitreledonella richardi Joubin 1918

FAMILY OCTOPODIDAE

Benthoctopus piscatorum (Verrill 1879)

FAMILY TREMOCTOPODIDAE

Tremoctopus violaceus Delle Chiaje 1830

FAMILY OCYTHOIDAE

Ocythoe tuberculata Rafinesque 1814

FAMILY ARGONAUTIDAE

Argonauta argo Linnaeus 1758
Argonauta hians Lightfoot 1786

FAMILY ALLOPOSIDAE

Alloposis mollis Verrill 1880

4 Carolinian and subtropical neritic species

These might occasionally occur north of Cape Hatteras.

Order Sepioidea

FAMILY SEPIOLIDAE

Semirossia equalis **(Voss 1950)**
Rossia bullisi **Voss 1956**
Rossia antillensis **Voss 1955**
Rossia tortugaensis **Voss 1956**

Order Teuthoidea

FAMILY PICKFORDIATEUTHIDAE

Pickfordiateuthis pulchella **Voss 1953**

FAMILY LOLIGINIDAE

Loligo ocula **Cohen 1976**
Loligo roperi **Cohen 1976**
Sepioteuthis sepioidea **(Blainville 1823)**

Order Octopoda

FAMILY OCTOPODIDAE

Octopus hummelincki **Adam 1936**
Octopus joubini **Robson 1929**
Octopus briareus **Robson 1929**
Octopus burryi **Voss 1950**
Octopus macropus **Risso 1826**
Octopus defilippi **Verany 1851**
Danoctopus schmidti **Joubin 1933**
Scaeurgus unicirrhus **(d'Orbigny 1840)**
Pteroctopus tetracirrhus **(Delle Chiaje 1830)**
Tetracheledone spinicirrhus **Voss 1955**

Some recently published comprehensive works on cephalopods

Boyle, P.R. (editor)
1983 Cephalopod life cycles. Vol. I, Species accounts. Acad. Press, London, 475 p.
1987 Cephalopod life cycles. Vol. II, Comparative reviews. Acad. Press, London, 441 p.

Hanlon, R.T. (editor)
1988 Life history, systematics and zoogeography of cephalopods in honor of S. Stillman Berry. Malacologia 29(1), 307 p.

Nesis, K.N.
1987 Cephalopods of the world; squids, cuttlefishes, octopuses and allies. [Engl. transl.] T.F.H. Publ., Neptune City, NJ, 351 p.

Nixon, M., and J.B. Messenger (editors)
1977 The biology of cephalopods. Symp. Zool. Soc. Lond. 38, 615 p.

Roper, C.F.E., C.C. Lu, and F.G. Hochberg (editors)
1983 Biology and resource potential of cephalopods. Mem. Natl. Mus. Vic. 44, 311 p.

Roper, C.F.E., M.J. Sweeney, and C.E. Nauen
1984 FAO species catalogue. Vol. 3, Cephalopods of the world. FAO Fish. Synop. (125)3, 277 p.

Citations

Brakoniecki, T.F.
1986 A generic revision of the family Loliginidae (Cephalopoda: Myopsida) based primarily on the comparative morphology of the hectocotylus. Diss., Univ. Miami, Coral Gables, FL 33124, 163 p.

Cohen, A.C.
1976 The systematics and distribution of *Loligo* (Cephalopoda, Myopsida) in the western North Atlantic, with descriptions of two new species. Malacologia 15(2):299-367.

Haefner, P.
1964 Morphometry of the common Atlantic squid, *Loligo pealei*, and the brief squid, *Lolliguncula brevis*, in Delaware Bay. Chesapeake Sci. 5:138-144.

Mangold, K.
1983 *Octopus vulgaris*. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. I, Species accounts, p. 335-364. Acad. Press, London.

Natsukari, Y.
1984 Taxonomical and morphological studies on the loliginid squids - IV. Two new genera of the family Loliginidae. Venus 43(3):229-239.

Nesis, K.N.
1987 Cephalopods of the world; squids, cuttlefishes, octopuses and allies. [Engl. transl.] T.F.H. Publ., Neptune City, NJ, 351 p.

O'Dor, R.K.
1983 *Illex illecebrosus*. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. I, Species accounts, p. 175-199. Acad. Press, London.

O'Dor, R.K., and E.G. MacAlaster
1983 *Bathypolypus arcticus*. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. I, Species accounts, p. 401-410. Acad. Press, London.

Okutani, T.
1983 Mollusks. *In* Takeda, M., and T. Okutani, Crustaceans and mollusks trawled off Suriname and French Guiana. Jpn. Mar. Fish. Resour. Res. Cent., Tokyo, 354 p.
1987 Juvenile morphology. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. II, Comparative reviews, p. 33-44. Acad. Press, London.

Roper, C.F.E.
1985 Is there a squid in your future: perspectives for new research. Am. Malacol. Bull., spec. ed. 1:93-100.

Roper, C.F.E., and C.C. Lu
1979 Rhynchoteuthion larvae of ommastrephid squids of the western North Atlantic, with the first description of larvae and juveniles of *Illex illecebrosus*. Proc. Biol. Soc. Wash. 91(4):1039-1059.

Roper, C.F.E., M.J. Sweeney, and C.E. Nauen
1984 FAO species catalogue. Vol. 3. Cephalopods of the world. FAO Fish. Synop. (125)3, 277 p.

Roper, C.F.E., and G.L. Voss
1983 Guidelines for taxonomic descriptions of cephalopod species. Mem. Natl. Mus. Vic. 44:49-63.

Summers, W.C.
1983 *Loligo pealei*. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. I, Species accounts, p. 115-142. Acad. Press, London.
Toll, R.B.
1982 The comparative morphology of the gladius in the Order Teuthoidea (Mollusca: Cephalopoda) in relation to systematics and phylogeny. Diss., Univ. Miami, Coral Gables, FL 33124, 390 p.
Vecchione, M.
1979 Larval development of *Illex* Steenstrup, 1880, in the northwestern Atlantic, with comments on *Illex* larval distribution. Proc. Biol. Soc. Wash. 91(4): 1060-1075.
1981 Aspects of the early life history of *Loligo pealei* (Cephalopoda; Myopsida). J. Shellfish. Res. 1(2):171-180.
1982 Morphology and development of planktonic *Lolliguncula brevis* (Cephalopoda: Myopsida). Proc. Biol. Soc. Wash. 95(3):601-608.
1987 Juvenile ecology. *In* Boyle, P.R. (ed.), Cephalopod life cycles. Vol. II, Comparative reviews, p. 61-84. Acad. Press, London.
Vecchione, M., and C.F.E. Roper
1986 Occurrence of larval *Illex illecebrosus* and other young cephalopods in the Slope Water/Gulf Stream interface. Proc. Biol. Soc. Wash. 99(4):703-708.
Verrill, A.E.
1880 The cephalopods of the north-east coast of America. Part I. The gigantic squids (*Architeuthis*) and their allies; with observations on similar large species from foreign localities. Trans. Conn. Acad. Sci. 5(5):177-257.
1881 The cephalopods of the north-east coast of America. Part II. The smaller cephalopods, including the "squids" and the octopi, with allied forms. Trans. Conn. Acad. Sci. 5(6):259-446.
Voss, G.L.
1977 Classification of Recent cephalopods. *In* Nixon, M., and J.B. Messenger (eds.), The biology of cephalopods, p. 575-579. Symp. Zool. Soc. Lond. 38, 615 p.
Young, R.E., and R.F. Harman
1988 "Larvae", "paralarva" and "subadult" in cephalopod terminology. Malacologia 29(1):201-207.

Systematic index

Note This is an index to the species included in the key and discussed in the text, but does not include the extralimital species listed on p. 18-20.

Bathypolypus arcticus 7
Illex
illecebrosus 13, 14
oxygonius 13, 14
Loliginidae 16
Loligo
pealei 12
plei 13
Lolliguncula brevis 11
Octopodidae 17
Octopus vulgaris 7
Ommastrephes
bartrami 14, 15
pteropus 14, 15
Ommastrephidae 17
Rossia
megaptera 9, 10
palpebrosa 9, 10
Semirossia tenera 9
Sepiolidae 16
Stoloteuthis leucoptera 8

Acknowledgments

Preparation of this manual was supported in part by a grant from the National Science Foundation to the Editorial Board of the "Marine Flora and Fauna of the Eastern United States."

The present manual has benefited from the artistic talents of Alan D. Hart (Figs. 16, 18-20, 25, 28, and 29), Cynthia Mason (Fig. 14), Keiko H. Moore (Fig. 22, which was redrawn from Toll 1982), and Ann Davis (Figs. 21, 23, and 26). Thanks are expressed to Walter Fischer for allowing the use of Figures 1-13 and 27, which were previously published by Roper et al. (1984); and to Wolfgang Sterrer for allowing the use of Figure 15. Figure 17 was originally published in Verrill (1881), and Figure 24 came from an unpublished thesis by Edward T. LaRoe. Donald D. Flescher has kindly sent many specimens from the NMFS Groundfish Survey over the past decade. Reviews of the manuscript of this manual by Bruce B. Collette, John B. Pearce, Warren F. Rathjen, Ronald B. Toll, and Richard E. Young are appreciated.

Preparation of manuals in the "Marine Flora and Fauna of the Eastern United States" subseries is coordinated by the following Board:

Coordinating Editor
Melbourne R. Carriker, College of Marine Studies, University of Delaware, Lewes, DE 19958.

Editorial Advisers
A. Ralph Cavaliere, Department of Biology, Gettysburg College, Gettysburg, PA 17325.
Arthur G. Humes, Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543.
David L. Pawson, Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.
Kenneth P. Sebens, Marine Science and Maritime Studies Center, Northeastern University, East Point, Nahant, MA 01908.
Ruth D. Turner, Museum of Comparative Zoology, Harvard University, Cambridge, MA 02138.
Robert T. Wilce, Department of Botany, University of Massachusetts, Amherst, MA 01002.

In addition to establishing the format for the "Marine Flora and Fauna of the Eastern United States," the Board invites systematists to collaborate in the preparation of manuals, reviews manuscripts, and advises the Scientific Editor of the National Marine Fisheries Service.

We regret to report that one of the original Editorial Advisers is no longer with us: Marie B. Abbott passed away in 1987. We would like to express our deep thanks to Marie for her enthusiasm and support during the formative stages of the "Marine Flora and Fauna of the Northeastern United States" and for her many subsequent editorial contributions.

We are pleased to report that a new systematist, Dr. Kenneth P. Sebens, has joined the Board of Editorial Advisers, and we look forward with much pleasure to his participation in the work of the Board.

Coordinating Editor's comments

Publication of the "Marine Flora and Fauna of the Eastern United States" is most timely in view of the growing universal emphasis on work in the marine environment and the critical need for precise and complete identification of organisms related to this work. It is essential, if at all possible, that organisms be identified accurately to species. Accurate scientific names of plants and animals unlock the great quantities of biological information stored in libraries, obviate duplication of research already done, and often make possible prediction of attributes of organisms that have been inadequately studied.

Michael Vecchione went to sea as a cabin boy on a three-masted schooner in Maine at the age of 16. He completed undergraduate studies in biology at the University of Miami in 1972, and then spent four and a half years in the United States Army. He has been working on cephalopods since his graduate studies on planktonic molluscs during 1976-79 at the Virginia Institute of Marine Science, School of Marine Science, College of William and Mary. After receiving the Ph.D. degree, he worked briefly for the U.S. Fish and Wildlife Service before accepting a faculty position at McNeese State University. There he studied cephalopods, zooplankton, and ichthyoplankton in addition to teaching during 1981-86. In 1986 he moved to his present position as Cephalopod Biologist at the National Marine Fisheries Service Systematics Laboratory at the National Museum of Natural History.

Clyde F.E. Roper's interest in marine biology developed while he was a commercial lobster fisherman in New Hampshire during summers through high school and undergraduate school at Transylvania College, Lexington, Kentucky. Lured to work as a research assistant in the summer following his first year of graduate school at the University of Miami's Institute of Marine Sciences (now Rosenstiel School of Marine and Atmospheric Science), Roper was captivated by cephalopods. He completed the M.S. and Ph.D. degrees at Miami, working primarily on oceanic and deep-sea squids. Roper has continued research on the systematics, biology, and behavior of cephalopods of the world at the Smithsonian Institution's National Museum of Natural History where he has been a Curator of Molluscs since 1966.

Michael J. Sweeney has worked at the National Museum of Natural History since 1968. His research interests are oceanic cephalopods and collections management. Restoration of antique automobiles occupies his spare time.

Published manuals

Marine Flora and Fauna of the Northeastern United States	NOAA Tech Rep. NMFS Circular no.	NTIS no.
Annelida: Oligochaeta *Cook, David G., and Ralph O. Brinkhurst*	374	COM 73 50670
Protozoa: Ciliophora *Borror, Arthur C.*	378	73 50888
Higher Plants of the Marine Fringe *Moul, Edwin T.*	384	74 50019
Pycnogonida *McCloskey, Lawrence R.*	386	74 50014
Crustacea: Stomatopoda *Manning, Raymond B.*	387	74 50487
Crustacea: Decapoda *Williams, Austin B.*	389	74 51194
Tardigrada *Pollock, Leland W.*	394	PB 257 987
Cnidaria: Scyphozoa *Larson, Ronald J.*	397	261 839
Higher Fungi: Ascomycetes, Deuteromycetes, and Basidiomycetes *Cavaliere, A.R.*	398	268 036
Copepoda: Harpacticoida *Coull, Bruce C.*	399	268 714
Sipuncula *Cutler, Edward B.*	403	273 062
Echinodermata: Holothuroidea *Pawson, David L.*	405	274 999
Copepoda: Lernaeopodidae and Sphyriidae *Ho, Ju-Shey*	406	280 040
Copepoda: Cyclopoids Parasitic on Fishes *Ho, Ju-Shey*	409	281 969
Crustacea: Branchiura *Cressey, Roger F.*	413	222 923
Protozoa: Sarcodina: Amoebae *Bovee, Eugene C., and Thomas K. Sawyer*	419	285 538
Crustacea: Cumacea *Watling, Les*	423	296 460
Arthropoda: Cirripedia *Zullo, Victor A.*	425	297 676
Cnidaria: Scleractinia *Cairns, Stephen D.*	438	124 520
Protozoa: Sarcodina: Benthic Foraminifera *Todd, Ruth, and Doris Low*	439	225 053
Turbellaria: Acoela and Nemertodermatida *Bush, Louise F.*	440	219 387
Lichens (Ascomycetes) of the Intertidal Region *Taylor, Ronald M.*	446	124 735

	NOAA Tech Rep. NMFS no.	
Echinodermata: Echinoidea *Serafy, D. Keith, and F. Julian Fell*	33	PC A03/MF A01

Marine Flora and Fauna of the Eastern United States

Cephalopoda *Vecchione, Michael, Clyde F.E. Roper, and Michael J. Sweeney*	73	

NOAA TECHNICAL REPORT NMFS

Guidelines for Contributors

FORM OF MANUSCRIPT

Authors are encouraged to retain manuscripts on word processing storage media, such as diskettes, floppy disks, cassette or magnetic tapes, and submit a hard copy run from the storage media. Hardcopy should be typed double-spaced on white bond paper in the following sequence:

Title page
Contents
Abstract
Text
Acknowledgments
Citations
Text footnotes
Appendix
Tables
Figure Legends
Figures

CONTENTS OF MANUSCRIPT

Contents. Contains all text headings with page numbers omitted.

Abstract. Not to exceed one double-spaced typed page. Should include a sentence or two explaining to the general reader why the research was undertaken and why the results should be viewed as important. Abstract should convey the main point of the paper and outline the results or conclusions. Footnotes and references do not belong in the abstract.

Text. A brief introduction should portray the broad significance of the paper. The entire text should be intelligible to readers from different disciplines. All technical terms should be defined. Follow the *U.S. Government Printing Office Style Manual*, 1984 edition.

Fishery nomenclature follows the American Fisheries Society Special Publication No. 12, *A List of Common and Scientific Names of Fishes from the United States and Canada*, 4th edition, 1980.

Abbreviations and symbols. Define all symbols, abbreviations, and acronyms. Define all symbols in equations and formulas. Abbreviate units of measure only when used with numerals or in tables and figures where there is lack of space. Periods are rarely used except for et al., vs., e.g., i.e., etc.

Measurements should be expressed in metric units. Other equivalent units may be given in parentheses.

Text footnotes. Type on a separate sheet from the text. Footnotes are not used for reference material or personal communications, but rather to explain or define terms in the text and for contribution numbers.

Personal communications are noted in parentheses in the text (name, affiliation, brief address including zip code, month and year).

Citations. All written sources should be listed in the Citations section, including unpublished and processed material. In text, cite as Smith and Jones (1977) or (Smith and Jones 1977); if more than one citation, list chronologically (Smith 1936; Jones 1975; Doe 1977). All sources cited in the text should be listed alphabetically by the senior authors' surname under the heading CITATIONS. Abbreviations of periodicals and serials should conform to the Biosis Data Base™. The author is responsible for the accuracy of all citations.

Acknowledgments. Gather all acknowledgments into a brief statement at the end of the text. Give credit only for exceptional contributions and not to those whose contributions are part of their normal duties.

Tables. Tables should supplement, not duplicate, the text. Each table should appear on a separate page, and be numbered consecutively. Headings should be short but amply descriptive so that the reader need not refer to the text. For values less than 1, zeros should precede all decimal points. Give each column a heading with units of measure indicated in parentheses. Do not change the unit of measure within a column. Table footnotes should be numbered consecutively in Arabic numerals across the page from left to right and down; to avoid confusion with exponents, place them to the left of numerals, e.g., $^{3}10$. All tables should be cited consecutively in the text and their placement, where first mentioned, indicated in the left-hand margin of the manuscript page. Lengthy tables that are typed in the proper format and are clean and legible can be used camera-ready.

Figures. Photographs and line drawings should be of professional quality—clear and concise—and reducible to 42 picas for full-page width or to 20 picas for a single-column width, and a maximum of 57 picas high. All illustrations must be proportioned so that they are legible when reduced to fit the page format. Line weight and lettering should be sharp and even. Lettering on graphs should be upper and lower case, and vertical lettering should be avoided as much as possible (except for vertical, y, axis). For values less than 1, zeros should precede all decimal points. Reproductions of line art work are accepted in the form of photographic prints from negatives or photomechanical transfer. Halftones should be sharply focused with good contrast. Micron rules should be inserted on electron micrographs, even when magnification is included in the figure legend. There should be good distinction between identifying letters (preferably press-on) and background of photograph. All figures should be cited consecutively in the text and their placement, where first mentioned, indicated in the left-hand margin of the manuscript page. Each figure should be labeled in pencil on the back. DO NOT SEND original or photographic prints of figures to the Scientific Editor; they will be requested when the manuscript is accepted for publication.

Copyright. Government publications are in the public domain, i.e., they are not protected by copyright.

SUBMISSION OF MANUSCRIPTS

Send original hardcopy and two duplicated copies of the manuscript to:

Dr. Andrew E. Dizon, Scientific Editor
NOAA Technical Reports NMFS
Southwest Fisheries Center
National Marine Fisheries Service, NOAA
P.O. Box 271
La Jolla, CA 92038-0271

Indicate whether word processing storage media are available, but do not forward disks until requested by Scientific Editor or Scientific Publications office.

Copies of published reports. For single monographs, the senior author will be provided with 50 copies free of charge and 50 to his or her organization. For collections of papers, each senior author will receive 50 separates and one cover, and his or her organization will receive the same. Additional copies may be purchased in lots of 100.

ADDITIONAL INFORMATION

Questions regarding editorial policy and procedures may be forwarded to:

Nancy Peacock, Managing Editor
NOAA Technical Reports NMFS
National Marine Fisheries Service, NOAA
Scientific Publications Office
Bin C15700
Seattle, WA 98115

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC
ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS OFFICE
BIN C15700
SEATTLE, WA 98115
OFFICIAL BUSINESS

Penalty for Private Use, $300

BULK RATE
POSTAGE & FEES PAID
U.S. Department of Commerce
Permit No. G-19

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 13, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS—Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS—Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS—Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS—Reports containing data, observations, instructions, etc. A partial listing includes data serials; predictions and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS—Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS—Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

Information on availability of NOAA publications can be obtained from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161